

Table of Contents

Title 28 EDUCATION

Part CXXIII. Bulletin 1962—Louisiana Content Standards, Benchmarks, and Grade Level Expectations for Science

Chapter 1.	Introduction	1
Chapter 3.	The Teaching and Learning of Science	4
Chapter 5.	Assessment	6
Chapter 7.	Content Strands	7
Chapter 9.	Strand One: Science As Inquiry	7
Chapter 11.	Strand Two: Physical Science	9
Chapter 13.	Strand Three: Life Science	11
Chapter 15.	Strand Four: Earth and Space Science.....	13
Chapter 17.	Strand Five: Science and the Environment	15
Chapter 19.	Grade Level Expectations.....	17
Chapter 21.	Glossary and References	43
Index	45

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Part CXXIII. Bulletin 1962—Louisiana Content Standards, Benchmarks, and Grade Level Expectations for Science

Chapter 1. Introduction

§101. Philosophy of Science Education

A. Science education in Louisiana must prepare students to become informed citizens who have acquired the necessary scientific and technological knowledge and skills to function responsibly in the global community of the 21st century. It is essential that everyone involved in science education provide an opportunity for all students to become scientifically literate and reflective of the inherent nature of scientific knowledge, methods, and processes.

B. Scientific knowledge should be constructed through a hands-on/minds-on approach with overarching concepts that connect the sciences and other disciplines. Methodology and teaching strategies should be inquiry-based and include hands-on/minds-on activities. Assessment should reflect this inquiry-based curriculum and instruction and be used to improve teaching and learning. It is the responsibility of the entire community to be involved in science education reform efforts. This widespread involvement should encourage students of this state to become life-long learners.

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§103. Need and Context for Reform

A. Over the past decade, due in part to *Science for All Americans*, published by the American Association for the Advancement of Science, educators across the country have reexamined the purposes of and approaches to science education. A major impetus for this critical look is our ever-changing society. Science and mathematics are increasingly important, as they provide a basis for citizens to make informed decisions and to earn a living in a scientific and technological world.

B. The movement to reform science education focuses on science literacy for all students. Project 2061 Update 1994 defines scientifically literate persons as those "equipped with the knowledge and skills they need to make sense of how the world works, to think critically and independently, and to lead responsible and productive lives in a culture increasingly shaped by science and technology" (American Association for the Advancement of Science [AAAS], 1994, p. 6). This intent of science literacy for everyone is reflected in the following national education goals originally put forward by the National Governor's Association.

1. American students will leave grades four, eight, and twelve having demonstrated competency over challenging subject matter including English, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography.

2. U.S. students will be first in the world in mathematics and science achievement.

3. Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and to exercise the rights and responsibilities of citizenship.

C. A number of national initiatives have helped to establish new perspectives and resources for reforming science education. The National Science Foundation's (NSF) Statewide Systemic Initiatives program funded selected states' efforts to make extensive changes in mathematics and science education. The American Association for the Advancement of Science established Project 2061, a long-range reform project that identifies key concepts in science, mathematics, and technology. The National Research Council, a division of the National Academy of Science, published the National Science Education Standards for Grades K-12 in 1996; and the National Science Teachers Association developed the Scope, Sequence, and Coordination project to implement reform approaches in secondary science classrooms.

D. It has become clear that the current approaches to science education must be reformed to meet the need for a scientifically literate citizenry and workforce. This reform effort in Louisiana began with a successful application to establish an NSF-funded statewide systemic initiative. A broad-based coalition of Louisianians secured a five-year, \$10 million grant for the Louisiana Systemic Initiatives Program (LaSIP). Louisiana provided matching funds from the Louisiana Board of Elementary and Secondary Education (LBESE) and the Louisiana Board of Regents (LBoR) for colleges and universities to support the work of reforming mathematics and science education.

E. The Louisiana Department of Education (LDE) was awarded a Dwight D. Eisenhower National Program for Mathematics and Science Education grant from the United States Department of Education. This grant enabled the LDE, in collaboration with LaSIP, to develop the Louisiana Mathematics and Science Curriculum and Assessment Frameworks.

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§105. Purpose of the Framework

A. This Framework document articulates, organizes, and integrates the content and processes of science education. It serves as a bridge between classroom practices and the national standards established by the science education community, as the standards define what a scientifically literate person should know, understand, and be able to do. It reflects research in science education as it outlines instructional content, teaching methodologies, and assessment strategies.

B. The Louisiana Science Framework is designed to guide the process of reforming science education in this state. It provides the following:

1. a master plan for developing the scientific literacy of Louisiana's students as they progress from kindergarten through Grade 12;
2. a design for science education that meets Louisiana's specific needs;
3. a catalyst for insightful discussion of the fundamental nature of science;
4. a guide for evaluating progress in achieving scientific literacy among the students of Louisiana; and
5. a vision of science education for the state and a tool to enable local districts, schools, and educators to grasp the nature, purpose, and role of science education.

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§107. Intended Audiences

A. This Framework, including the Introduction, Teaching and Learning of Science, Assessment, and Content Standards, is intended to be used mainly by teachers and curriculum developers to plan curriculum, instruction, and assessment for teachers and students.

B. The Introduction and Teaching and Learning of Science sections of the Framework can be used by a broad audience as a reference point to achieve a common vision of what and how science should be taught in Louisiana schools. The Framework does not address issues such as Standards for the Professional Development for Teachers of Science, Science Education Program Standards, and Science Education System Standards. The National Science Education Standards (NSES) includes standards and information on the above topics, as well as Science and Technology, Science in Personal and Social Perspective, and History and Nature of Science. Anyone interested in professional development, program, or system standards should obtain a copy of the NSES. Anyone looking at the NSES for the first time should be sure to look at the Changing Emphases pages at the end of each section, which

give an overview of the kinds of changes needed in standards-based science education.

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§109. Intended Use

A. This Framework serves as a guide for curriculum and instruction and as a general reference to the basic principles of science education.

B. Intended uses for this Framework include the following:

1. for teachers and curriculum developers, a guide for planning curriculum, instruction, and assessment;
2. for parents, a means for assessing the effectiveness of their children's science education;
3. for administrators and school board members, a vision for science education and a basis for planning resource allocations, material purchases, local curriculum development, and teachers' professional development;
4. for policy makers and state education staffs, a basis for developing laws, policies, and funding priorities to support local reforms;
5. for staff developers, a basis for creating professional development materials and strategies designed to increase teachers' knowledge of science content, teaching methodologies, and assessment strategies;
6. for assessment specialists and test developers, a guide for the development of an assessment framework to assess students' scientific understanding and ability more effectively;
7. for colleges and universities, a guide for content and design of teacher preparation programs; and
8. for business and industry leaders and governmental agencies, a basis for developing effective partnerships and local reforms for funding instructional materials and professional development.

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§111. Louisiana Content Standards Foundation Skills

A. The Louisiana Content Standards Task Force has developed the following foundation skills which should apply to all students in all disciplines.

1. Communication. A process by which information is exchanged and a concept of "meaning" is created and shared between individuals through a common system of symbols, signs, or behavior. Students should be able to communicate clearly, fluently, strategically, technologically, critically, and creatively in society and in a variety of workplaces. This

process can best be accomplished through use of the following skills: reading, writing, speaking, listening, viewing, and visually representing.

2. **Problem Solving.** The identification of an obstacle or challenge and the application of knowledge and thinking processes which include reasoning, decision making, and inquiry in order to reach a solution using multiple pathways, even when no routine path is apparent.

3. **Resource Access and Utilization.** The process of identifying, locating, selecting, and using resource tools to help in analyzing, synthesizing, and communicating information. The identification and employment of appropriate tools, techniques, and technologies are essential in all learning processes. These resource tools include pen, pencil, and paper; audio/video material, word processors, computers, interactive devices, telecommunication, and other emerging technologies.

4. **Linking and Generating Knowledge.** The effective use of cognitive processes to generate and link knowledge across the disciplines and in a variety of contexts. In order to engage in the principles of continued improvement, students must be able to transfer and elaborate on these processes. "Transfer" refers to the ability to apply a strategy or content knowledge effectively in a setting or context other than that in which it was originally learned. "Elaboration" refers to monitoring, adjusting, and expanding strategies into other contexts.

5. **Citizenship.** The application of the understanding of the ideals, rights, and responsibilities of active participation in a democratic republic that includes working respectfully and productively together for the benefit of the individual and the community; being accountable for one's choices and actions and understanding their impact on oneself and others; knowing one's civil, constitutional, and statutory rights; and mentoring others to be productive citizens and lifelong learners.

NOTE: These foundation skills are listed numerically in parentheses at the end of each benchmark.

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§113. Information Literacy Model for Lifelong Learning

A. Students must become competent and independent users of information to be productive citizens of the 21st century. They must be prepared to live in an information-rich and changing global society. Due to the rapid growth of technology, the amount of information available is accelerating so quickly that teachers are no longer able to impart a complete knowledge base in a subject area. In addition, students entering the workforce must know how to access information, solve problems, make decisions, and work as part of a team. Therefore, information literacy, the ability to recognize an information need and then locate, evaluate, and effectively use the needed information, is a

basic skill essential to the 21st century workplace and home. Information literate students are self-directed learners who, individually or collaboratively, use information responsibly to create quality products and to be productive citizens. Information literacy skills must not be taught in isolation; they must be integrated across all content areas, utilizing fully the resources of the classroom, the school library media center, and the community. The Information Literacy Model for Lifelong Learners is a framework that teachers at all levels can apply to help students become independent lifelong learners.

1. **Defining/Focusing.** The first task is to recognize that an information need exists. Students make preliminary decisions about the type of information needed based on prior knowledge.

2. **Selecting Tools and Resources.** After students decide what information is needed, they then develop search strategies for locating and accessing appropriate, relevant sources in the school library media center, community libraries and agencies, resource people, and others as appropriate.

3. **Extracting and Recording.** Students examine the resources for readability, currency, usefulness, and bias. This task involves skimming or listening for key words, "chunking" reading, finding main ideas, and taking notes.

4. **Processing Information.** After recording information, students must examine and evaluate the data in order to utilize the information retrieved. Students must interact with the information by categorizing, analyzing, evaluating, and comparing for bias, inadequacies, omissions, errors, and value judgments. Based on their findings, they either move on to the next step or do additional research.

5. **Organizing Information.** Students effectively sort, manipulate, and organize the information that was retrieved. They make decisions on how to use and communicate their findings.

6. **Presenting Findings.** Students apply and communicate what they have learned (e.g., research report, project, illustration, dramatization, portfolio, book, book report, map, oral/audio/visual presentation, game, bibliography, hyperstack).

7. **Evaluating Efforts.** Throughout the information problem solving process, students evaluate their efforts. This assists students in determining the effectiveness of the research process. The final product may be evaluated by the teacher and also other qualified or interested resource persons.

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Chapter 3. The Teaching and Learning of Science

§301. Nature of Science

A. Science is a way of thinking and a system of knowledge that uses reason, observation, experimentation, and imagination. The goal of science is to describe, explain, and predict natural phenomena and processes. Science shares some characteristics with other forms of scholarly inquiry, but it is unique in several important ways. Science attempts to meet the criteria of testability, objectivity, and consistency. Scientific information is continuously open to review and modification; science is not a static body of knowledge. One of the functions of science education is to teach students to understand scientific information and the processes by which it was derived.

B. Science is a complex social activity. Scientific knowledge is generated not only by individuals but also by scientists who work cooperatively in laboratories and in the field. For scientific ideas to become widely accepted, peers must review, analyze, and critique results through journal articles, replication of experiments, and presentations at professional meetings. This process has implications for the way science is taught. It suggests the importance of working in cooperative groups, recording and presenting laboratory and field results, debating issues, and posing new questions based on current findings.

C. Scientists generally work with theories, which are explanations or predictions drawn from analyses of past scientific results. Investigations of the validity of a theory may take many different forms, including observing, collecting specimens and data for analysis, and conducting experiments.

D. Few scientists actually follow the orderly steps of what is known as the "scientific method." Instead, they may omit, move, or augment one or more of these steps. Scientists' explanations about what happens in the world come partly from what they observe and partly from what they infer; sometimes scientists have different explanations for the same set of observations. Scientists also use their imaginations to consider possible causes or outcomes: A number of scientific discoveries have been based on a scientist's idea, which was then tested for validity. It is always important for scientists to consider their own biases or preconceptions and to seek to eliminate these from their work.

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§303. Unifying Concepts and Processes

A. Science, mathematics, and technology are crosscut by big ideas that transcend disciplinary boundaries. They are useful in teaching as a means of organizing science content in ways that are meaningful for students and that promote interdisciplinary instruction. Current approaches to science

teaching emphasize the need to convey "big ideas" rather than isolated facts that may not fit into any meaningful pattern for the student. When instruction is organized around large concepts, it is easier for students to find meaning in specific facts and to relate them to the larger concepts presented.

B. Unifying concepts and processes provide students with powerful ideas to help them understand the natural world. These include, but are not limited to, the following:

1. systems, order, and organization;
2. evidence, models, and explanation;
3. change, constancy, and measurement; and
4. form and function.

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§305. Instructional Issues

A. The purpose of science education is not for students to memorize the "right" answer, but for them to move along a learning continuum toward a deeper understanding of science concepts and processes. Current research indicates that it is best for understanding to be constructed actively by the learner. This learning style offers a new role for the science teacher as a facilitator of learning versus an imparter of knowledge. Instruction should minimize rote learning and focus on in-depth understanding of major concepts and topics, with students actively exploring those ideas through activities they can relate to their own lives. Students often work cooperatively in small groups to exchange and critique their own ideas, with the teacher facilitating discussion rather than providing answers. Science is presented as a human enterprise and a continuing process for extending understanding, instead of the ultimate, unalterable truth. Learning activities are often interdisciplinary, stressing the connections between the sciences and other subjects. Science teachers must have a solid understanding of the basic concepts and processes of science in order to construct meaningful science activities that address all students' diverse experiences and learning styles.

B. During the last decade, a major change has occurred in science educators' views about how science learning takes place. The science education research community now views effective science teaching as helping the learner build upon prior knowledge to construct a scientific understanding of the phenomena being studied, making learning a lifelong construction project.

C. Research studies have shown that students begin school not as "blank slates," but with a substantial set of ideas about how the world functions. These ideas usually have developed without any exposure to formal science instruction, but rather through observation, guesswork, and bits of information filtered down from adults and other children. Students often form misconceptions about such

basic processes as why the seasons change, how gravity works, and what electricity is. The most important finding from these research studies is not that students have preconceptions about science, but that their misconceptions are deeply rooted and tenacious.

D. To address this instructional dilemma, teachers need to elicit students' ideas and then allow the students to test their ideas against scientific knowledge and thereby construct their own understanding. It is important to underscore that the learners must do the constructing, not the teacher. The teacher should choose excellent teaching activities and materials, but it is the learner who must actively connect the new knowledge to what he or she already knows.

E. Activities or processes that facilitate this construction of knowledge are listed below in three broad categories.

1. Using Knowledge:
 - a. describing;
 - b. explaining;
 - c. predicting;
 - d. designing;
 - e. analyzing;
2. Constructing New Knowledge:
 - a. asking questions;
 - b. solving problems;
 - c. interpreting text;
 - d. reconstructing knowledge;
3. Reflecting on Knowledge:
 - a. justifying;
 - b. criticizing;
 - c. describing limits;
 - d. making connections;
 - e. taking perspectives;
 - f. describing interactions (Michigan State Board of Education, 1991).

NOTE: These activities will offer students the opportunity to dispel their misconceptions as they continually construct new scientific knowledge.

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§307. Technology

A. Just as science is both a process and content, so is technology. As a process, technology is the using of scientific knowledge and other resources to develop new products and processes. "...[T]he relationship between science and technology is so close that any presentation of

science without developing understanding of technology would portray an inaccurate picture of science" [*National Science Education Standards Draft* (Standards), 1994, pp. v-153].

B. While the emphasis in science is on gaining knowledge of the natural world, the emphasis in technology is on finding practical ways to apply that knowledge to solve problems. "Science helps drive technology, as it provides knowledge for better understanding, instruments, and techniques. Technology is essential to science because it enables observations of phenomena that are far beyond the capabilities of scientists due to factors such as distance, location, size, and speed and provides tools for investigations, inquiry, and analysis" (*NSE Standards*, pp. v-95).

C. The emphasis of technology in the classroom should be on knowledge construction to solve problems. The posing and solving of problems that are increasingly complex will enable students to develop skills that are vital to living in a technical world.

D. Students should develop an awareness and appreciation for the continuing progress in technology as it affects the quality of individual lives as well as society, in order to become better informed citizens and consumers and become computer literate and proficient, as it applies to the computer's capability to acquire data (with sensors), interpret data (by graphing), and as a research tool (library and Internet).

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§309. Materials and Equipment

A. Instructional materials and equipment can increase students' interest and improve achievement; they deserve a prominent place in science programs. Students should have access to materials and equipment and be offered opportunities to learn to use them effectively. It is essential that classroom teachers have the necessary nonconsumable and consumable materials and equipment provided and that they be maintained and/or replenished.

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§311. Science and Equity

A. The reform emphasis on science literacy has no boundaries. It excludes no one regardless of gender, race, ethnicity, and socioeconomic status. Unfortunately, because this has not always been the case in science education, it is not reflected in the enrollment in high school science classes and in the adult workforce of scientists. "To neglect the science education of any (as has happened too often to girls and minority students) is to deprive them of a basic education . . . and deprive the nation of talented workers and

informed citizens, a loss the nation can ill afford" (*Science for All Americans*, 1989, pp. 156-157).

B. It is imperative that reform science education in Louisiana include hands-on, inquiry-based science teaching that will develop thinking skills in all students for a lifetime of use. Pre-conceived notions that science has a very narrow scope and that it is limited to a select few can be dispelled by developing critical thinking skills in all students and by developing the practice of using these thinking skills in every area of life involving cognitive processes. Development of these skills begins with kindergarten science explorations. Memorizing science facts will not suffice. It is critical that appropriate instructional tools be provided for all students so that this type of inquiry-based instruction can be implemented.

C. However, this philosophy is not enough to address the equity issue. Science education must also include keeping students in contact with culturally appropriate role models and career information. Reform efforts must dispel preconceived notions about who can be a scientist. All students must become aware of their own abilities to achieve in science. The content and methods of the Louisiana Science Framework reflect careful consideration of equity to assure that all students are provided the opportunity to succeed in learning science.

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HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2770 (November 2005).

Chapter 5. Assessment

§501. Purpose of Assessment

A. "Assessment is a systemic, multi-step process involving the collection and interpretation of educational data" (*NSE Standards*, p. 76). The purpose of assessment is to provide information to all the stakeholders in order to improve teaching and learning. Teachers, students, and parents need feedback on student progress. School administrators, educational planners, and the community need information to determine the overall effectiveness of the science program. As science instruction moves from a focus on facts to a focus on in-depth understanding of major concepts and processes, the assessment of science learning also must change.

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§503. Classroom Assessment

A. Assessment serves many important purposes in the science classroom: diagnostic (to plan instruction to fit the student's prior knowledge), formative (to improve performance and adapt instruction), and summative (to report on final performance). The purpose of the assessment determines the assessment technique.

1. Assessment should parallel instruction. As science education develops toward a hands-on, inquiry-based approach to learning, assessments will need to become more activity-based.

2. Assessment should be fair and equitable. Throughout the learning process, expectations should be clearly articulated to students. Assessment activities that measure skills beyond recall of facts should be challenging and thoughtful; however, all students should be given learning opportunities that enable them to apply concepts and skills successfully. In order to determine what students know and are able to do as a result of science instruction, teachers must develop assessments that are free of gender, racial, and language barriers.

3. Assessment should include data from multiple sources. Varied assessment strategies provide opportunities for teachers to observe students as they conduct a variety of tasks in different settings. Student-generated products from group work, entries from individual science journals, student-designed investigations and exhibitions, and student-constructed written responses are rich sources of data that enable teachers to determine students' understanding of science concepts and processes.

B. Assessment should encourage the development of higher order thinking skills; therefore, assessment must be designed to require students not just to recall random facts, but to demonstrate scientific problem-solving and conceptual knowledge. New designs for assessment must encourage forms of active assessment that are imbedded in instruction.

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HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2771 (November 2005).

§505. Large-Scale Assessment

A. Large-scale assessment refers to assessment at the district, state, and national level. These external assessments are conducted for the purpose of providing the following:

1. information for policy makers;
 2. data for program evaluation;
 3. a measure of pupil progression;
 4. data for district, state, and national comparisons;
- and
5. a criterion for graduation.

B. Assessment can have a powerful influence on curriculum and instruction; therefore, the utilization of assessment techniques that closely parallel effective instructional activities and outcomes are beneficial in the science classroom.

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HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2771 (November 2005).

Chapter 7. Content Strands

§701. Science Strands

A. The Science Framework is divided into five strands: Science as Inquiry, Physical Science, Life Science, Earth and Space Science, and Science and the Environment. Each of the strands is organized into grade clusters and introduced with a focus statement that describes important aspects inherent to that section, followed by a standard (overarching goal) and benchmarks. Benchmarks, for the purpose of this document, are defined as broad statements of process and/or content that are to be used as a reference to develop curriculum and assess student progress. They are based on the National Science Education Standards and reflect the goal of increased science literacy for all students. The benchmarks were designed to provide breadth and continuity of content throughout the K-12 curriculum, while allowing for the flexibility of instruction in the individual classroom.

B. The first strand, Science as Inquiry, centers on the scientific process of inquiry, which citizens continually practice as they seek to understand issues, solve problems, and make decisions in everyday life. It is included in the benchmarks, along with the subject matter in Physical Science, Life Science, Earth and Space Science, and Science and the Environment, to emphasize the importance of the processes of science. It is envisioned that integration of the strands will occur and that there will be integration across the sciences and other disciplines.

C. To assist the teacher, handbooks that consist of the Framework, a sample module, and selected activities are under development for Grades K-8. The learning modules are designed as models and are provided for the grade clusters of K-2, 3-4, and 5-8. They consist of readings for teachers and students, a vignette, teaching materials, and learning activities that integrate assessment into the instruction. These modules are designed to aid in the transfer of the broad benchmarks into classroom instruction. The handbook is intended to assist in the development of curriculum and teaching methods that promote science literacy for all students.

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Chapter 9. Strand One: Science As Inquiry

§901. Science As Inquiry

A. Focus. The process of scientific inquiry involves "asking a question, planning and conducting an investigation, using appropriate tools, mathematics, and techniques, thinking critically and logically about the relationships between evidence and explanations,

constructing and analyzing alternative explanations, and communicating scientific arguments" (*NSE Standards*, pp. v-4). Students develop these skills as they are encouraged to think scientifically rather than simply memorize and/or study science facts.

B. Standard. The students will do science by engaging in partial and full inquiries that are within their developmental capabilities.

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§903. Benchmarks K-4

A. In Grades K-4, what students know and are able to do includes:

1. the abilities necessary to do scientific inquiry:

a. SI-E-A1: asking appropriate questions about organisms and events in the environment (1, 3);

b. SI-E-A2: planning and/or designing and conducting a scientific investigation (2, 3);

c. SI-E-A3: communicating that observations are made with one's senses (1, 3);

d. SI-E-A4: employing equipment and tools to gather data and extend the sensory observations (3);

e. SI-E-A5: using data, including numbers and graphs, to explain observations and experiments (1, 2, 3);

f. SI-E-A6: communicating observations and experiments in oral and written formats (1, 3);

g. SI-E-A7: utilizing safety procedures during experiments (3, 5);

2. understanding scientific inquiry:

a. SI-E-B1: categorizing questions into what is known, what is not known, and what questions need to be explained (2, 4);

b. SI-E-B2: using appropriate experiments depending on the questions to be explored (2, 4);

c. SI-E-B3: choosing appropriate equipment and tools to conduct an experiment (2, 3, 5);

d. SI-E-B4: developing explanations by using observations and experiments (1, 2, 3, 4);

e. SI-E-B5: presenting the results of experiments (1, 3);

f. SI-E-B6: reviewing and asking questions about the results of investigations (1, 3, 4).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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§905. Benchmarks 5-8

A. As students in Grades 5-8 extend their knowledge, what they know and are able to do includes:

1. the abilities necessary to do scientific inquiry:
 - a. SI-M-A1: identifying questions that can be used to design a scientific investigation (1, 2, 3);
 - b. SI-M-A2: designing and conducting a scientific investigation (1, 2, 3, 4, 5);
 - c. SI-M-A3: using mathematics and appropriate tools and techniques to gather, analyze, and interpret data (1, 2, 3, 4, 5);
 - d. SI-M-A4: developing descriptions, explanations, and graphs using data (1, 2, 3, 4);
 - e. SI-M-A5: developing models and predictions using the relationships between data and explanations (1, 2, 3, 4);
 - f. SI-M-A6: comparing alternative explanations and predictions (1, 3, 4);
 - g. SI-M-A7: communicating scientific procedures, information, and explanations (1, 3);
 - h. SI-M-A8: utilizing safety procedures during scientific investigations (3, 5);
2. understanding scientific inquiry:
 - a. SI-M-B1: recognizing that different kinds of questions guide different kinds of scientific investigations (2, 4);
 - b. SI-M-B2: communicating that current scientific knowledge guides scientific investigations (1, 3, 4);
 - c. SI-M-B3: understanding that mathematics, technology, and scientific techniques used in an experiment can limit or enhance the accuracy of scientific knowledge (3, 4);
 - d. SI-M-B4: using data and logical arguments to propose, modify, or elaborate on principles and models (1, 2, 3, 4);
 - e. SI-M-B5: understanding that scientific knowledge is enhanced through peer review, alternative explanations, and constructive criticism (1, 4, 5);
 - f. SI-M-B6: communicating that scientific investigations can result in new ideas, new methods or procedures, and new technologies (1, 3, 4);
 - g. SI-M-B7: understanding that scientific development/technology is driven by societal needs and funding (4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2772 (November 2005).

§907. Benchmarks 9-12

A. As students in Grades 9-12 extend their knowledge, what they know and are able to do includes:

1. the abilities necessary to do scientific inquiry:
 - a. SI-H-A1: identifying questions and concepts that guide scientific investigations (2, 4);
 - b. SI-H-A2: designing and conducting scientific investigations (1, 2, 3, 4, 5);
 - c. SI-H-A3: using technology and mathematics to improve investigations and communications (1, 2, 3);
 - d. SI-H-A4: formulating and revising scientific explanations and models using logic and evidence (1, 2, 3, 4);
 - e. SI-H-A5: recognizing and analyzing alternative explanations and models (4);
 - f. SI-H-A6: communicating and defending a scientific argument (1, 3, 4);
 - g. SI-H-A7: utilizing science safety procedures during scientific investigations (3, 5);
2. understanding scientific inquiry:
 - a. SI-H-B1: communicating that scientists usually base their investigations on existing models, explanations, and theories (1, 3, 4);
 - b. SI-H-B2: communicating that scientists conduct investigations for a variety of reasons, such as exploration of new areas, discovery of new aspects of the natural world, confirmation of prior investigations, evaluation of current theories, and comparison of models and theories (1, 3, 4);
 - c. SI-H-B3: communicating that scientists rely on technology to enhance the gathering and manipulation of data (1, 3);
 - d. SI-H-B4: analyzing a proposed explanation of scientific evidence according to the following criteria: follow a logical structure, follow rules of evidence, allow for questions and modifications, and is based on historical and current scientific knowledge (2, 4, 5);
 - e. SI-H-B5: communicating that the results of scientific inquiry, new knowledge, and methods emerge from different types of investigations and public communication among scientists (1, 3, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2773 (November 2005).

Chapter 11. Strand Two: Physical Science

§1101. Physical Science

A. Focus. Exploring the characteristics, forces, and changes in objects and materials encourages students to develop an understanding of the world in which they live to establish a basis for a lifelong study of their world. As students increase their understanding and abilities, they will be able to use more sophisticated qualitative and quantitative methods to construct and analyze information. This study will enable them to make informed decisions based on a better understanding of how things work in the physical world.

B. Standard. Students will develop an understanding of the characteristics and interrelationships of matter and energy in the physical world.

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HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2773 (November 2005).

§1103. Benchmarks K-4

A. In Grades K-4, what students know and are able to do includes:

1. properties of objects and materials:

a. PS-E-A1: observing, describing, and classifying objects by properties (size, weight, shape, color, texture, and temperature) (4);

b. PS-E-A2: measuring properties of objects using appropriate materials, tools, and technology (3, 4, 5);

c. PS-E-A3: observing and describing the objects by the properties of the materials from which they are made (paper, wood, metal) (2, 4);

d. PS-E-A4: describing the properties of the different states of matter and identifying the conditions that cause matter to change states (2, 3);

e. PS-E-A5: creating mixtures and separating them based on differences in properties (salt, sand) (2, 3);

2. position and motion of objects:

a. PS-E-B1: observing and describing the position of an object relative to another object or the background (1, 2);

b. PS-E-B2: exploring and recognizing that the position and motion of objects can be changed by pushing or pulling (force) over time (1, 2, 3);

c. PS-E-B3: describing an object's motion by tracing and measuring its position over time (1, 2, 3, 4);

d. PS-E-B4: investigating and describing how the motion of an object is related to the strength of the force (pushing or pulling) and the mass of the object (1, 2, 3, 4);

3. forms of energy:

a. PS-E-C1: experimenting and communicating how vibrations of objects produce sound and how changing the rate of vibration varies the pitch (2);

b. PS-E-C2: investigating and describing how light travels and what happens when light strikes an object (reflection, refraction, and absorption) (2);

c. PS-E-C3: investigating and describing different ways heat can be produced and moved from one object to another by conduction (2);

d. PS-E-C4: investigating and describing how electricity travels in a circuit (2);

e. PS-E-C5: investigating and communicating that magnetism and gravity can exert forces on objects without touching the objects (2);

f. PS-E-C6: exploring and describing simple energy transformations (2);

g. PS-E-C7: exploring and describing the uses of energy at school, home, and play (1, 2, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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§1105. Benchmarks 5-8

A. As students in Grades 5-8 extend their knowledge, what they know and are able to do includes:

1. properties and changes of properties in matter:

a. PS-M-A1: investigating, measuring, and communicating the properties of different substances which are independent of the amount of the substance (1, 2, 3, 4);

b. PS-M-A2: understanding that all matter is made up of particles called atoms and that atoms of different elements are different (2, 4);

c. PS-M-A3: grouping substances according to similar properties and/or behaviors (4);

d. PS-M-A4: understanding that atoms and molecules are perpetually in motion (4);

e. PS-M-A5: investigating the relationships among temperature, molecular motion, phase changes, and physical properties of matter (2, 3);

f. PS-M-A6: investigating chemical reactions between different substances to discover that new substances formed may have new physical properties and do have new chemical properties (2, 3, 4, 5);

g. PS-M-A7: understanding that during a chemical reaction in a closed system, the mass of the products is equal to that of the reactants (2, 3, 4);

- h. PS-M-A8: discovering and recording how factors such as temperature influence chemical reactions (2);
- i. PS-M-A9: identifying elements and compounds found in common foods, clothing, household materials, and automobiles (1, 2, 3, 4, 5);
- 2. motions and forces:
 - a. PS-M-B1: describing and graphing the motions of objects (1, 2, 3);
 - b. PS-M-B2: recognizing different forces and describing their effects (gravity, electrical, magnetic) (1, 2);
 - c. PS-M-B3: understanding that, when an object is not being subjected to a force, it will continue to move at a constant speed and in a straight line (2, 3, 4);
 - d. PS-M-B4: describing how forces acting on an object will reinforce or cancel one another, depending upon their direction and magnitude (1, 2);
 - e. PS-M-B5: understanding that unbalanced forces will cause changes in the speed or direction of an object's motion (2, 4);
- 3. transformations of energy:
 - a. PS-M-C1: identifying and comparing the characteristics of different types of energy (2, 3, 4);
 - b. PS-M-C2: understanding the different kinds of energy transformations and the fact that energy can be neither destroyed nor created (2, 3, 4);
 - c. PS-M-C3: understanding that the sun is a major source of energy and that energy arrives at the earth's surface as light with a range of wavelengths (2, 3, 4);
 - d. PS-M-C4: observing and describing the interactions of light and matter (reflection, refraction, absorption, transmission, scattering) (1, 2, 3, 4);
 - e. PS-M-C5: investigating and describing the movement of heat and the effects of heat in objects and systems (2, 3, 4);
 - f. PS-M-C6: describing the types of energy that can be involved, converted, or released in electrical circuits (2, 3, 4);
 - g. PS-M-C7: understanding that energy is involved in chemical reactions (2, 4);
 - h. PS-M-C8: comparing the uses of different energy resources and their effects upon the environment (1, 2, 3, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2774 (November 2005).

§1107. Benchmarks 9-12

A. As students in Grades 9-12 extend their knowledge and abilities, what they know and are able to do includes:

- 1. measurement and symbolic representation:
 - a. PS-H-A1: manipulating and analyzing quantitative data using the SI system (2, 3, 4);
 - b. PS-H-A2: understanding the language of chemistry (formulas, equations, symbols) and its relationship to molecules, atoms, ions, and subatomic particles (1, 2, 3, 4);
- 2. atomic structure:
 - a. PS-H-B1: describing the structure of the atom and identifying and characterizing the particles that compose it (including the structure and properties of isotopes) (1, 2, 4);
 - b. PS-H-B2: describing the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay) (1, 2, 3, 4, 5);
 - c. PS-H-B3: understanding that an atom's electron configuration, particularly that of the outermost electrons, determines the chemical properties of that atom (2, 3, 4);
- 3. the structure and properties of matter:
 - a. PS-H-C1: distinguishing among elements, compounds, and/or mixtures (1, 2, 4);
 - b. PS-H-C2: discovering the patterns of physical and chemical properties found on the periodic table of the elements (2, 4);
 - c. PS-H-C3: understanding that physical properties of substances reflect the nature of interactions among its particles (2, 4);
 - d. PS-H-C4: separating mixtures based upon the physical properties of their components (2);
 - e. PS-H-C5: understanding that chemical bonds are formed between atoms when the outermost electrons are transferred or shared to produce ionic and covalent compounds (1, 2, 4);
 - f. PS-H-C6: recognizing that carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures (1, 2, 3, 4);
 - g. PS-H-C7: using the kinetic theory to describe the behavior of atoms and molecules during phase changes and to describe the behavior of matter in its different phases (1, 2, 4);
- 4. chemical reactions:
 - a. PS-H-D1: observing and describing changes in matter and citing evidence of chemical change (1, 2, 4);
 - b. PS-H-D2: comparing, contrasting, and measuring the pH of acids and bases using a variety of indicators (1, 2, 3, 4);

c. PS-H-D3: writing balanced equations to represent a variety of chemical reactions (acid/base, oxidation/reduction, etc.) (2);

d. PS-H-D4: analyzing the factors that affect the rate and equilibrium of a chemical reaction (1, 2, 4);

e. PS-H-D5: applying the law of conservation of matter to chemical reactions (1, 2, 4);

f. PS-H-D6: comparing and contrasting the energy changes that accompany changes in matter (1, 2, 4);

g. PS-H-D7: identifying important chemical reactions that occur in living systems, the home, industry, and the environment (1, 2, 3, 4, 5);

5. forces and motion:

a. PS-H-E1: recognizing the characteristics and relative strengths of the forces of nature (gravitational, electrical, magnetic, nuclear) (4, 5);

b. PS-H-E2: understanding the relationship of displacement, time, rate of motion, and rate of change of motion; representing rate and changes of motion mathematically and graphically (1, 2, 3, 4);

c. PS-H-E3: understanding effects of forces on changes in motion as explained by Newtonian mechanics (1, 4);

d. PS-H-E4: illustrating how frame of reference affects our ability to judge motion (1, 2, 4);

6. energy:

a. PS-H-F1: describing and representing relationships among energy, work, power, and efficiency (2, 3, 4);

b. PS-H-F2: applying the universal law of conservation of matter, energy, and momentum, and recognizing their implications (2, 3, 4, 5);

7. interactions of energy and matter:

a. PS-H-G1: giving examples of the transport of energy through wave action (1, 4);

b. PS-H-G2: analyzing the relationship and interaction of magnetic and electrical fields and the forces they produce (1, 2, 3, 4);

c. PS-H-G3: characterizing and differentiating electromagnetic and mechanical waves and their effects on objects as well as humans (1, 2, 4);

d. PS-H-G4: explaining the possible hazards of exposure to various forms and amounts of energy (1, 4, 5)

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2774 (November 2005).

Chapter 13. Strand Three: Life Science

§1301. Life Science

A. Focus. As investigations of the living environment are conducted, the rationales are set to establish further observations, measurements, and classifications of the various life forms. Patterns of similarities and differences within the diversity of life establish the basis for understanding the special relationships among living things in ecosystems.

B. Standard. The students will become aware of the characteristics and life cycles of organisms and understand their relationships to each other and to their environment.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2775 (November 2005).

§1303. Benchmarks K-4

A. In Grades K-4, what students know and are able to do includes:

1. characteristics of organisms, which includes:

a. LS-E-A1: identifying the needs of plants and animals, based on age-appropriate recorded observations (1, 2, 3, 4);

b. LS-E-A2: distinguishing between living and nonliving things (1, 2, 3, 4);

c. LS-E-A3: locating and comparing major plant and animal structures and their functions (1, 3);

d. LS-E-A4: recognizing that there is great diversity among organisms (1);

e. LS-E-A5: locating major human body organs and describing their functions (1, 4);

f. LS-E-A6: recognizing the food groups necessary to maintain a healthy body (1, 2, 4, 5);

2. life cycles of organisms, which include:

a. LS-E-B1: observing and describing the life cycles of some plants and animals (1, 3);

b. LS-E-B2: observing, comparing, and grouping plants and animals according to likenesses and/or differences (1, 2, 4);

c. LS-E-B3: observing and recording how the offspring of plants and animals are similar to their parents (1, 2, 3, 4);

d. LS-E-B4: observing, recording, and graphing student growth over time using a variety of quantitative measures (height, weight, linear measure of feet and hands, etc.) (1, 3);

3. Organisms and their environments, which include:

a. LS-E-C1: examining the habitats of plants and animals and determining how basic needs are met within each habitat (1, 2, 3, 4, 5);

b. LS-E-C2: describing how the features of some plants and animals enable them to live in specific habitats (1, 2, 3, 4, 5);

c. LS-E-C3: observing animals and plants and describing interaction or interdependence (1, 4).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2775 (November 2005).

§1305. Benchmarks 5-8

A. As students in Grades 5-8 extend their knowledge, what they know and are able to do includes:

1. structure and function in living systems, which includes:

a. LS-M-A1: describing the observable components and functions of a cell, such as the cell membrane, nucleus, and movement of molecules into and out of cells (1);

b. LS-M-A2: comparing and contrasting the basic structures and functions of different plant and animal cells (1, 2, 3, 4);

c. LS-M-A3: observing and analyzing the growth and development of selected organisms, including a seed plant, an insect with complete metamorphosis, and an amphibian (1, 2, 3, 4);

d. LS-M-A4: describing the basic processes of photosynthesis and respiration and their importance to life (1, 4, 5);

e. LS-M-A5: investigating human body systems and their functions (including circulatory, digestive, skeletal, respiratory) (1, 3, 4);

f. LS-M-A6: describing how the human body changes with age and listing factors that affect the length and quality of life (1, 2, 3, 4, 5);

g. LS-M-A7: describing communicable and noncommunicable diseases (1, 2, 3, 4, 5);

2. reproduction and heredity, which includes:

a. LS-M-B1: describing the importance of body cell division (mitosis) and sex cell production (meiosis) (1, 4);

b. LS-M-B2: describing the role of chromosomes and genes in heredity (1, 4);

c. LS-M-B3: describing how heredity allows parents to pass certain traits to offspring (1, 4);

3. populations and ecosystems, which include:

a. LS-M-C1: constructing and using classification systems based on the structure of organisms (1, 2, 3, 4);

b. LS-M-C2: modeling and interpreting food chains and food webs (1, 2, 3, 4);

c. LS-M-C3: investigating major ecosystems and recognizing physical properties and organisms within each (1, 2, 3, 4, 5);

d. LS-M-C4: explaining the interaction and interdependence of nonliving and living components within ecosystems (1, 2, 3, 4, 5);

4. adaptations of organisms:

a. LS-M-D1: describing the importance of plant and animal adaptation, including local examples (1, 3, 4, 5);

b. LS-M-D2: explaining how some members of a species survive under changed environmental conditions (1, 2, 3, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2776 (November 2005).

§1307. Benchmarks 9-12

A. As students in Grades 9-12 extend their knowledge, what they know and are able to do includes:

1. the cell, which includes:

a. LS-H-A1: observing cells, identifying organelles, relating structure to function, and differentiating among cell types (1, 2, 3, 4);

b. LS-H-A2: demonstrating a knowledge of cellular transport (1, 3, 4);

c. LS-H-A3: investigating cell differentiation and describing stages of embryological development in representative organisms (1, 2, 3, 4);

2. the molecular basis of heredity:

a. LS-H-B1: explaining the relationship among chromosomes, DNA, genes, RNA, and proteins (1, 3, 4);

b. LS-H-B2: comparing and contrasting mitosis and meiosis (1, 3, 4);

c. LS-H-B3: describing the transmission of traits from parent to offspring and the influence of environmental factors on gene expression (1, 2, 3, 4, 5);

d. LS-H-B4: exploring advances in biotechnology and identifying possible positive and negative effects (1, 2, 3, 4, 5);

3. biological evolution, which includes:

a. LS-H-C1: exploring experimental evidence that supports the theory of the origin of life (1, 3);

b. LS-H-C2: recognizing the evidence for evolution (1, 3, 4);

- c. LS-H-C3: discussing the patterns, mechanisms, and rate of evolution (1, 3, 4);
- d. LS-H-C4: classifying organisms (1, 2, 3, 4);
- e. LS-H-C5: distinguishing among the kingdoms (1, 3, 4);
- f. LS-H-C6: comparing and contrasting life cycles of organisms (1, 2, 3, 4);
- g. LS-H-C7: comparing viruses to cells (1, 2, 3, 4);
- 4. interdependence of organisms, which includes:
 - a. LS-H-D1: illustrating the biogeochemical cycles and explaining their importance (1, 2, 3, 4, 5);
 - b. LS-H-D2: describing trophic levels and energy flows (1, 3, 4, 5);
 - c. LS-H-D3: investigating population dynamics (2, 3, 4, 5);
 - d. LS-H-D4: exploring how humans have impacted ecosystems and the need for societies to plan for the future (1, 2, 4, 5);
- 5. matter, energy, and organization of living systems:
 - a. LS-H-E1: comparing and contrasting photosynthesis and cellular respiration; emphasizing their relationships (1, 2, 3, 4);
 - b. LS-H-E2: recognizing the importance of the ATP cycle in energy usage within the cell (1, 2, 3, 4);
 - c. LS-H-E3: differentiating among levels of biological organization (1, 4);
- 6. systems and the behavior of organisms:
 - a. LS-H-F1: identifying the structure and functions of organ systems (1, 3, 4);
 - b. LS-H-F2: identifying mechanisms involved in homeostasis (1, 3, 4);
 - c. LS-H-F3: recognizing that behavior is the response of an organism to internal changes and/or external stimuli (1, 3, 4);
 - d. LS-H-F4: recognizing that behavior patterns have adaptive value (3, 4);
- 7. personal and community health:
 - a. LS-H-G1: relating fitness and health to longevity (1, 3, 4, 5);
 - b. LS-H-G2: contrasting how organisms cause disease (1, 3, 4, 5);
 - c. LS-H-G3: explaining the role of the immune system in fighting disease (1, 3, 4, 5);
 - d. LS-H-G4: exploring current research on the major diseases with regard to cause, symptoms, treatment, prevention, and cure (1, 3, 4, 5);

- e. LS-H-G5: researching technology used in prevention, diagnosis, and treatment of diseases/disorders (1, 3, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2776 (November 2005).

Chapter 15. Strand Four: Earth and Space Science

§1501. Earth and Space Science

A. Focus. In order to develop a basic understanding of our world, it is essential for students to reflect upon the structure, order, and origin of the universe. This understanding occurs gradually over time as students observe, investigate, model, describe, and find patterns in a changing world. As humans modify their surroundings, they must reflect upon the consequences that these changes will bring. Scientific knowledge about environmental forces and resources will provide a rich topic for critical thinking by students to analyze the effects of their choices on the world.

B. Standard. The students will develop an understanding of the properties of earth materials, the structure of the earth system, the earth's history, and the earth's place in the universe.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2777 (November 2005).

§1503. Benchmarks K-4

A. In Grades K-4, what students know and are able to do includes:

- 1. properties of earth materials, which include:

- a. ESS-E-A1: understanding that earth materials are rocks, minerals, and soils (1);
- b. ESS-E-A2: understanding that approximately three-fourths of the earth's surface is covered with water and how this condition affects weather patterns and climates (1);
- c. ESS-E-A3: investigating, observing, and describing how water changes from one form to another and interacts with the atmosphere (2, 4);
- d. ESS-E-A4: investigating, observing, measuring, and describing changes in daily weather patterns and phenomena (2, 4);
- e. ESS-E-A5: observing and communicating that rocks are composed of various substances (1);
- f. ESS-E-A6: observing and describing variations in soil (1);

g. ESS-E-A7: investigating fossils and describing how they provide evidence about plants and animals that lived long ago and the environment in which they lived (1, 2, 4);

2. objects in the sky, which include:

a. ESS-E-B1: observing and describing the characteristics of objects in the sky (1);

b. ESS-E-B2: demonstrating how the relationship of the earth, moon, and sun causes eclipses and moon phases (2, 3, 4);

c. ESS-E-B3: observing and recording the changing appearances and positions of the moon in the sky at night and determining the monthly pattern of lunar change (1, 2, 3, 4);

d. ESS-E-B4: modeling changes that occur because of the rotation of the earth (alternation of night and day) and the revolution of the earth around the sun (1, 2, 3, 4);

e. ESS-E-B5: understanding that the sun, a star, is a source of heat and light energy and identifying its effects upon the earth (1, 2, 3, 4);

f. ESS-E-B6: understanding that knowledge of the earth as well as of the universe is gained through space exploration (1).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

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§1505. Benchmarks 5-8 (Warning: Benchmarks 9-12 need to be addressed if Earth Science is not offered at the high school level.)

A. As students in Grades 5-8 extend their knowledge, what they know and are able to do includes:

1. structure of the earth:

a. ESS-M-A1: understanding that the earth is layered by density with an inner and outer core, a mantle, and a thin outer crust (1);

b. ESS-M-A2: understanding that the earth's crust and solid upper mantle are dividing plates that move in response to convection currents (energy transfers) in the mantle (1);

c. ESS-M-A3: investigating the characteristics of earthquakes and volcanoes and identifying zones where they may occur (2, 3, 4);

d. ESS-M-A4: investigating how soils are formed from weathered rock and decomposed organic material (2, 3, 4);

e. ESS-M-A5: identifying the characteristics and uses of minerals and rocks and recognizing that rocks are mixtures of minerals (2, 3, 4);

f. ESS-M-A6: explaining the processes involved in the rock cycle (1, 4);

g. ESS-M-A7: modeling how landforms result from the interaction of constructive and destructive forces (1, 2, 3, 4);

h. ESS-M-A8: identifying the man-made and natural causes of coastal erosion and the steps taken to combat it (1, 2, 3, 4, 5);

i. ESS-M-A9: compare and contrast topographic features of the ocean floor to those formed above sea level (2, 3, 4);

j. ESS-M-A10: explaining (illustrating) how water circulates, on and through the crust, in the oceans, and in the atmosphere, in the water cycle (1, 4);

k. ESS-M-A11: understanding that the atmosphere interacts with the hydrosphere to affect weather and climate conditions (1, 4);

1. ESS-M-A12: predicting weather patterns through use of a weather map (1, 2, 3, 4, 5);

2. earth story:

a. ESS-M-B1: investigating how fossils show the development of life over time (2, 3, 4);

b. ESS-M-B2: devising a model that demonstrates supporting evidence that the earth has existed for a vast period of time (1, 2, 3, 4);

c. ESS-M-B3: understanding that earth processes such as erosion and weathering affect the earth today and are similar to those which occurred in the past (1, 2, 3, 4);

3. earth in the solar system:

a. ESS-M-C1: identifying the characteristics of the sun and other stars (1, 2, 3, 4);

b. ESS-M-C2: comparing and contrasting the celestial bodies in our solar system (2, 4);

c. ESS-M-C3: investigating the force of gravity and the ways gravity governs motion in the solar system and objects on earth (2, 3, 4);

d. ESS-M-C4: modeling the motions of the earth-moon-sun system to explain day and night, a year, eclipses, moon phases, and tides (1, 2, 3, 4);

e. ESS-M-C5: modeling the position of the earth in relationship to other objects in the solar system (1, 2, 3, 4);

f. ESS-M-C6: modeling and describing how radiant energy from the sun affects phenomena on the earth's surface, such as winds, ocean currents, and the water cycle (1, 2, 3, 4);

g. ESS-M-C7: modeling and explaining how seasons result from variations in amount of the sun's energy hitting the surface due to the tilt of earth's rotation on its axis and the length of the day (1, 2, 3, 4);

h. ESS-M-C8: understanding that space exploration is an active area of scientific and technological research and development (1, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2777 (November 2005).

§1507. Benchmarks 9-12

A. As students in Grades 9-12 extend their knowledge, what they know and are able to do includes:

1. energy in the earth system:

a. ESS-H-A1: investigating the methods of energy transfer and identifying the sun as the major source of energy for most of the earth's systems (1, 3, 4);

b. ESS-H-A2: modeling the seasonal changes in the relative position and appearance of the sun and inferring the consequences with respect to the earth's temperature (1, 2, 3, 4);

c. ESS-H-A3: explaining fission and fusion in relation to the earth's internal and external heat sources (1, 3, 4);

d. ESS-H-A4: explaining how decay of radioactive isotopes and the gravitational energy from the earth's original formation generates the earth's internal heat (1, 3, 4);

e. ESS-H-A5: demonstrating how the sun's radiant energy causes convection currents within the atmosphere and the oceans (1, 2, 3, 4);

f. ESS-H-A6: describing the energy transfer from the sun to the earth and its atmosphere as it relates to the development of weather and climate patterns (1, 2, 3, 4);

g. ESS-H-A7: modeling the transfer of the earth's internal heat by way of convection currents in the mantle which powers the movement of the lithospheric plates (1, 2, 3, 4);

2. geochemical cycles:

a. ESS-H-B1: illustrating how stable chemical atoms or elements are recycled through the solid earth, oceans, atmosphere, and organisms (1, 2, 3, 4);

b. ESS-H-B2: demonstrating earth's internal and external energy sources as forces in moving chemical atoms or elements (1, 2, 3, 4);

3. the origin and evolution of the earth system:

a. ESS-H-C1: explaining the formation of the solar system from a nebular cloud of dust and gas (1, 2, 3, 4);

b. ESS-H-C2: estimating the age of the earth by using dating techniques (1, 2, 3, 4);

c. ESS-H-C3: communicating the geologic development of Louisiana (1, 2, 3, 4);

d. ESS-H-C4: examining fossil evidence as it relates to the evolution of life and the resulting changes in the amount of oxygen in the atmosphere (1, 2, 3, 4);

e. ESS-H-C5: explaining that natural processes and changes in the earth system may take place in a matter of seconds or develop over billions of years (1, 2, 3, 4);

4. the original and evolution of the universe:

a. ESS-H-D1: identifying scientific evidence that supports the latest theory of the age and origin of the universe (1, 2, 3, 4);

b. ESS-H-D2: describing the organization of the known universe (1, 3, 4);

c. ESS-H-D3: comparing and contrasting the sun with other stars (1, 4);

d. ESS-H-D4: identifying the elements found in the sun and other stars by investigating the spectra (1, 2, 3, 4);

e. ESS-H-D5: describing the role of hydrogen in the formation of all the natural elements (1, 4);

f. ESS-H-D6: demonstrating the laws of motion for orbiting bodies (1, 3, 4);

g. ESS-H-D7: describe the impact of technology on the study of the earth, the solar system, and the universe (1, 2, 3, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2778 (November 2005).

Chapter 17. Strand Five: Science and the Environment

§1701. Science and the Environment

A. Focus. Environmental education is a process aimed at the development of a literate citizenry which is aware of and shows concern for the total environment and its associated problems. This goal will be met by developing the knowledge, attitudes, motivation, commitment, and skills to work individually and collectively toward the solutions of current problems and the prevention of new ones.

B. Standard. In learning environmental science, students will develop an appreciation of the natural environment, learn the importance of environmental quality, and acquire a sense of stewardship. As consumers and citizens, they will be able to recognize how our personal, professional, and political actions affect the natural world.

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§1703. Benchmarks K-4

A. In Grades K-4, what students know and are able to do includes:

1. SE-E-A1: understanding that an "ecosystem" is made of living and non-living components (1, 3, 4);
2. SE-E-A2: understanding the components of a food chain (1, 3, 4);
3. SE-E-A3: identifying ways in which humans have altered their environment, both in positive and negative ways, either for themselves or for other living things (1, 2, 3, 4, 5);
4. SE-E-A4: understanding that the original sources of all material goods are natural resources and that the conserving and recycling of natural resources is a form of stewardship (1, 2, 3, 4, 5);
5. SE-E-A5: understanding that most plant and animal species are threatened or endangered today due to habitat loss or change (1, 2, 4).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

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§1705. Benchmarks 5-8

A. As students in Grades 5-8 extend their knowledge, what they know and are able to do includes:

1. SE-M-A1: demonstrating knowledge that an ecosystem includes living and nonliving factors and that humans are an integral part of ecosystems (1, 3, 4, 5);
2. SE-M-A2: demonstrating an understanding of how carrying capacity and limiting factors affect plant and animal populations (1, 2, 3, 4, 5);
3. SE-M-A3: defining the concept of pollutant and describing the effects of various pollutants on ecosystems (1, 2, 3, 4, 5);
4. SE-M-A4: understanding that human actions can create risks and consequences in the environment (1, 2, 3, 4, 5);
5. SE-M-A5: tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem (1, 2, 3, 4, 5);
6. SE-E-A6: distinguishing between renewable and nonrenewable resources and understanding that nonrenewable natural resources are not replenished through the natural cycles and thus are strictly limited in quantity (1, 2, 3, 4, 5);

7. SE-M-A7: demonstrating knowledge of the natural cycles, such as the carbon cycle, nitrogen cycle, water cycle, and oxygen cycle (1, 2, 4);

8. SE-M-A8: investigating and analyzing how technology affects the physical, chemical, and biological factors in an ecosystem (1, 2, 3, 4, 5);

9. SE-M-A9: demonstrating relationships of characteristics of soil types to agricultural practices and productivity (1, 2, 3, 4, 5);

10. SE-M-A10: identifying types of soil erosion and preventive measures (1, 2, 3, 4, 5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2779 (November 2005).

§1707. Benchmarks 9-12

A. As students in Grades 9-12 extend their knowledge, what they know and are able to do includes:

1. ecological systems and interactions, which include:
 - a. SE-H-A1: demonstrating an understanding of the functions of earth's major ecological systems (1, 2, 3, 4);
 - b. SE-H-A2: investigating the flow of energy in ecological systems (1, 2, 3, 4);
 - c. SE-H-A3: describing how habitat, carrying capacity, and limiting factors influence plant and animal populations (including humans) (1, 3, 4, 5);
 - d. SE-H-A4: understanding that change is a fundamental characteristic of every ecosystem and that ecosystems have varying capacities for change and recovery (1, 2, 3, 4, 5);
 - e. SE-H-A5: describing the dynamic interactions between divisions of the biosphere (1, 3, 4);
 - f. SE-H-A6: describing and explaining the earth's biochemical and geochemical cycles and their relationship to ecosystem stability (1, 2, 4);
 - g. SE-H-A7: comparing and contrasting the dynamic interaction within the biosphere (1, 2, 4);
 - h. SE-H-A8: analyzing evidence that plant and animal species have evolved physical, biochemical, and/or behavioral adaptations to their environments (1, 2, 3, 4, 5);
 - i. SE-H-A9: demonstrating an understanding of influencing factors of biodiversity (1, 3, 4, 5);
 - j. SE-H-A10: explaining that all species represent a vital link in a complex web of interaction (1, 3, 4, 5);
 - k. SE-H-A11: understanding how pollutants can affect living systems (1, 2, 3, 4, 5);
2. resources and resource management, which include:

a. SE-H-B1: explaining the relationships between renewable and nonrenewable resources (1, 3, 4);

b. SE-H-B2: comparing and contrasting conserving and preserving resources (1, 3, 4);

c. SE-H-B3: recognizing that population size and geographic and economic factors result in the inequitable distribution of the earth's resources (1, 2, 3, 4, 5);

d. SE-H-B4: comparing and contrasting long and short-term consequences of resource management (1, 2, 3, 4, 5);

e. SE-H-B5: analyzing resource management (1, 2, 3, 4, 5);

f. SE-H-B6: recognizing that sustainable development is a process of change in which resource use, investment direction, technological development, and institutional change meet society's present as well as future needs (1, 2, 3, 4, 5);

3. environmental awareness and protection:

a. SE-H-C1: evaluating the dynamic interaction of land, water, and air and its relationship to living things in maintaining a healthy environment (1, 2, 3, 4, 5);

b. SE-H-C2: evaluating the relationships between quality of life and environmental quality (1, 2, 3, 4, 5);

c. SE-H-C3: investigating and communicating how environmental policy is formed by the interaction of social, economic, technological, and political considerations (1, 2, 3, 4, 5);

d. SE-H-C4: demonstrating that environmental decisions include analyses that incorporate ecological, health, social, and economic factors (1, 2, 3, 4, 5);

e. SE-H-C5: analyzing how public support affects the creation and enforcement of environmental laws and regulations (1, 2, 3, 4, 5);

4. personal choices and responsible actions:

a. SE-H-D1: demonstrating the effects of personal choices and actions on the natural environment (1, 2, 3, 4, 5);

b. SE-H-D2: analyzing how individuals are capable of reducing and reversing their impact on the environment through thinking, planning, education, collaboration, and action (1, 2, 3, 4, 5);

c. SE-H-D3: demonstrating that the most important factor in prevention and control of pollution is education (1, 2, 3, 4, 5);

d. SE-H-D4: demonstrating a knowledge that environmental issues should be a local and global concern (1, 2, 3, 4, 5);

e. SE-H-D5: recognizing that the development of accountability toward the environment is essential for sustainability (1, 2, 3, 4, 5);

f. SE-H-D6: developing an awareness of personal responsibility as stewards of the local and global environment (1, 2, 3, 4, 5).

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AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

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Chapter 19. Grade Level Expectations

§1901. Prekindergarten

A. Science as Inquiry: Strand One

1. The Abilities Necessary to Do Scientific Inquiry

a. GLE 1: Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (PK-CS-I1) (SI-E-A1).

b. GLE 2: Pose questions that can be answered by using students' own observations and scientific knowledge (PK-CS-I1) (SI-E-A1).

c. GLE 3: Use the five senses to describe observations (PK-CS-P3) (SI-E-A3).

d. GLE 4: Select and use developmentally appropriate equipment and tools and units of measurement to observe and collect data (PK-CS-I4) (SI-E-A4).

e. GLE 5: Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate (PK-CS-I5) (SI-E-A5) (SI-E-B4).

f. GLE 6: Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios) (PK-CS-I5) (SI-E-A6).

g. GLE 7: Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties) (PK-CS-I4) (SI-E-A7).

2. Understanding Scientific Inquiry

a. GLE 8: Recognize that a variety of tools can be used to examine objects at different degrees of magnification (e.g., hand lens, microscope) (PK-CS-I4) (SI-E-B3).

B. Physical Science: Strand Two

1. Properties of Objects and Materials

a. GLE 9: Sort objects using one characteristic (PK-CS-P2) (PS-E-A1).

b. GLE 10: Determine whether objects float or sink through investigations (PK-CS-P1) (PS-E-A1).

c. GLE 11: Describe properties of materials by using observations made with the aid of equipment such as

magnets, magnifying glasses, pan balances, and mirrors (PK-CS-P4) (PS-E-A2).

d. GLE 12: Determine whether one object weighs more or less than another by using a pan balance (PK-CS-I4) (PS-E-A2).

e. GLE 13: Compare the properties of different solids and liquids through observation (PK-CS-P1) (PS-E-A4).

f. GLE 14: Identify components of simple mixtures (e.g., salt/water, rice/beans, iron filings/sand) (PK-CS-P1) (PS-E-A5).

2. Position and Motion of Objects

a. GLE 15: Demonstrate motion by using students' own bodies (PK-CS-P3) (PS-E-B3).

b. GLE 16: Explore the motion of objects by using balls, toy cars, or spinning tops (PK-CS-I2) (PS-E-B3).

3. Forms of Energy

a. GLE 17: Identify different sounds as *soft* or *loud* (PK-CS-P3) (PS-E-C1).

b. GLE 18: Identify selected substances as *hot* or *cold* (PK-CS-P2) (PS-E-C3).

C. Life Science: Strand Three

1. Characteristics of Organisms

a. GLE 19: Identify parts of the body and how they move (PK-CS-L1) (LS-E-A3).

b. GLE 20: Give examples of different kinds of plants and different kinds of animals (PK-CS-L1) (LS-E-A4).

c. GLE 21: Distinguish food items from nonfood items (PK-CS-L1) (LS-E-A6).

2. Life Cycles of Organisms

a. GLE 22: Learn about animals and plants through nonfiction literature (PK-CS-L1) (LS-E-B1).

b. GLE 23: Observe and care for pets and plants (PK-CS-L1) (LS-E-B1).

3. Organisms and Their Environments

a. GLE 24: Describe plants and animals in the schoolyard or home environments (PK-CS-L1) (LS-E-C1).

D. Earth and Space Science: Strand Four

1. Properties of Earth Materials

a. GLE 25: Explore and describe various properties of rocks, minerals, and soils (PK-CS-L2) (ESS-E-A1).

b. GLE 26: Describe the weather and its daily changes (PK-CS-ES2) (ESS-E-A4).

c. GLE 27: Describe different types of weather students have experienced and give examples of how daily

activities and appropriate attire are affected by weather conditions (PK-CS-ES2) (ESS-E-A4).

2. Objects in the Sky

a. GLE 28: Learn about objects in the sky through nonfiction literature (PK-CS-ES3) (ESS-E-B1).

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§1903. Kindergarten

A. Science as Inquiry: Strand One

1. The Abilities to Do Scientific Inquiry

a. GLE 1: Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (SI-E-A1).

b. GLE 2: Pose questions that can be answered by using students' own observations and scientific knowledge (SI-E-A1).

c. GLE 3: Predict and anticipate possible outcomes (SI-E-A2).

d. GLE 4: Use the five senses to describe observations (SI-E-A3).

e. GLE 5: Measure and record length and temperature in both metric system and U.S. system units (SI-E-A4).

f. GLE 6: Select and use developmentally appropriate equipment and tools and units of measurement to observe and collect data (SI-E-A4).

g. GLE 7: Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate (SI-E-A5) (SI-E-B4).

h. GLE 8: Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios) (SI-E-A6).

i. GLE 9: Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties) (SI-E-A7).

2. Understanding Scientific Inquiry

a. GLE 10: Recognize that a variety of tools can be used to examine objects at different degrees of magnification (e.g., hand lens, microscope) (SI-E-B3).

B. Physical Science: Strand Two

1. Properties of Objects and Materials

a. GLE 11: Identify objects by using the senses (PS-E-A1).

b. GLE 12: Construct patterns by using color, size, and shape of objects (PS-E-A1).

c. GLE 13: Sort objects based on their properties (e.g., size, weight, texture) (PS-E-A1).

d. GLE 14: Determine whether objects are magnetic or nonmagnetic (PS-E-A1).

e. GLE 15: Create and separate mixtures (e.g., oil/water, rice/beans) (PS-E-A5).

2. Position and Motion of Objects

a. GLE 16: Follow directions using vocabulary such as *front/back*, *above/below*, *right/left*, and *next to* (PS-E-B1).

b. GLE 17: Trace the motion of an object, such as a ball or toy car, as it rolls (PS-E-B3).

c. GLE 18: Sequence the relative order of the speed of various objects (e.g., snails, turtles, tricycles, bicycles, cars, airplanes) (PS-E-B3).

3. Forms of Energy

a. GLE 19: Demonstrate and identify sounds as *soft* or *loud* (PS-E-C1).

b. GLE 20: Identify objects that give off heat, such as people, animals, and the sun (PS-E-C3).

C. Life Science: Strand Three

1. Characteristics of Organisms

a. GLE 21: Record observations on the growth of plant seeds (LS-E-A1).

b. GLE 22: Classify objects in a variety of settings as *living (biotic)* or *nonliving (abiotic)* (LS-E-A2).

c. GLE 23: Compare the human body at various stages of development (LS-E-A3).

d. GLE 24: Compare the human body with plants and animals (LS-E-A3).

e. GLE 25: Identify easily observable variations within types of plants and animals (e.g., features of classmates, varieties of trees, breeds of dogs) (LS-E-A4).

f. GLE 26: Classify various foods into the major groups (e.g., bread, meat, vegetable, fruit) (LS-E-A6).

g. GLE 27: Determine which foods are superior for developing a healthy body (LS-E-A6).

2. Life Cycles of Organisms

a. GLE 28: Observe life cycles and describe changes (e.g., humans, dogs, insects) (LS-E-B1).

b. GLE 29: Match models of baby animals with their parents (LS-E-B3).

D. Earth and Space Science: Strand Four

1. Properties of Earth Materials

a. GLE 30: Distinguish between areas of earth covered by land and water (ESS-E-A2).

b. GLE 31: Identify the patterns in information recorded on a weather calendar (ESS-E-A4).

2. Objects in the Sky

a. GLE 32: Discuss and differentiate objects seen in the day and/or night sky (e.g., clouds, sun, stars, moon) (ESS-E-B1).

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§1905. First Grade

A. Science as Inquiry: Strand One

1. The Abilities to Do Scientific Inquiry

a. GLE 1: Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (SI-E-A1).

b. GLE 2: Pose questions that can be answered by using students' own observations and scientific knowledge (SI-E-A1).

c. GLE 3: Predict and anticipate possible outcomes (SI-E-A2).

d. GLE 4: Use a variety of methods and materials and multiple trials to investigate ideas (observe, measure, accurately record data) (SI-E-A2).

e. GLE 5: Use the five senses to describe observations (SI-E-A3).

f. GLE 6: Measure and record length and temperature in both metric system and U.S. system units (SI-E-A4).

g. GLE 7: Select and use developmentally appropriate equipment and tools and units of measurement to observe and collect data (SI-E-A4).

h. GLE 8: Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate (SI-E-A5) (SI-E-B4).

i. GLE 9: Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios) (SI-E-A6).

j. GLE 10: Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties) (SI-E-A7).

2. Understanding Scientific Inquiry

a. GLE 11: Recognize that a variety of tools can be used to examine objects at different degrees of magnification (e.g., hand lens, microscope) (SI-E-B3).

b. GLE 12: Explain and give examples of how scientific discoveries have affected society (SI-E-B6).

B. Physical Science: Strand Two

1. Properties of Objects and Materials

- a. GLE 13: Sort a group of objects by using multiple characteristics (PS-E-A1).
- b. GLE 14: Order objects by weight/mass (PS-E-A1).
- c. GLE 15: Measure length and width of a variety of objects and materials by using nonstandard tools, such as a paper clip, cube, shoe, and hands (PS-E-A2).
- d. GLE 16: Observe and describe common properties of solids, liquids, and gases (PS-E-A4).
- e. GLE 17: Sort and classify objects by their state of matter (PS-E-A4).

2. Forms of Energy

- a. GLE 18: Demonstrate how sound is made in a variety of ways (e.g., singing, whispering, striking an object) (PS-E-C1).
- b. GLE 19: Describe and demonstrate the volume of sound (e.g., soft, loud) (PS-E-C1).
- c. GLE 20: Use a flashlight and various objects and materials to determine if light is transmitted or reflected (PS-E-C2).
- d. GLE 21: Demonstrate that light can be reflected onto another object by using a mirror (PS-E-C2).
- e. GLE 22: Identify some examples where heat is released (e.g., burning candles, rubbing hands, running) (PS-E-C3).
- f. GLE 23: Identify materials attracted by magnets (PS-E-C5).
- g. GLE 24: Determine, through experimentation, which poles of magnets are attracted to each other and which poles repel each other (PS-E-C5).
- h. GLE 25: Discuss what type of energy makes objects work (e.g., car/gasoline, waterwheel/water, lamp/electricity) (PS-E-C6) (PS-E-C7).

C. Life Science: Strand Three

1. Characteristics of Organisms

- a. GLE 26: Describe the differences between plants and animals (LS-E-A1).
- b. GLE 27: Identify what animals and plants need to grow and develop (LS-E-A1).
- c. GLE 28: Describe the characteristics of *living (biotic)* and *nonliving (abiotic)* things (LS-E-A2).
- d. GLE 29: Describe basic functions of parts of the body (e.g., lungs, heart, bones, muscles) (LS-E-A3).

2. Life Cycles of Organisms

- a. GLE 30: Record and share observations of changes in developing plants (LS-E-B1).

- b. GLE 31: Describe how animals and their offspring are similar and how they are different (LS-E-B3).

3. Organisms and Their Environments

- a. GLE 32: Describe features of some animals that benefit them in their environments (LS-E-C1).
- b. GLE 33: Explain how pets' needs are met in their habitats (LS-E-C1).
- c. GLE 34: Record evidence of plants and animals in the schoolyard or other environments (LS-E-C2).

D. Earth and Space Science: Strand Four

1. Properties of Earth Materials

- a. GLE 35: Examine soils to determine that they are often found in layers (ESS-E-A1).
- b. GLE 36: Locate and compare the relative proportions of land and water found on earth (ESS-E-A2).
- c. GLE 37: Illustrate how water changes from one form to another (e.g., freezing, melting, evaporating) (ESS-E-A3).
- d. GLE 38: Compare weather patterns as they relate to seasonal changes in students' immediate environment (ESS-E-A4).
- e. GLE 39: Identify the characteristics of soil, according to color, texture, and components, including *living (biotic)* and *nonliving (abiotic)* substances (ESS-E-A6).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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§1907. Second Grade

A. Science as Inquiry: Strand One

1. The Abilities to Do Scientific Inquiry

- a. GLE 1: Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (SI-E-A1).
- b. GLE 2: Pose questions that can be answered by using students' own observations, scientific knowledge, and testable scientific investigations (SI-E-A1).
- c. GLE 3: Use observations to design and conduct simple investigations or experiments to answer testable questions (SI-E-A2).
- d. GLE 4: Predict and anticipate possible outcomes (SI-E-A2).
- e. GLE 5: Use a variety of methods and materials and multiple trials to investigate ideas (observe, measure, accurately record data) (SI-E-A2).
- f. GLE 6: Use the five senses to describe observations (SI-E-A3).

g. GLE 7: Measure and record length and temperature in both metric system and U.S. system units (SI-E-A4).

h. GLE 8: Select and use developmentally appropriate equipment and tools (e.g., magnifying lenses, graduated cylinders) and units of measurement to observe and collect data (SI-E-A4).

i. GLE 9: Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate (SI-E-A5) (SI-E-B4).

j. GLE 10: Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios) (SI-E-A6).

k. GLE 11: Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties) (SI-E-A7).

2. Understanding Scientific Inquiry

a. GLE 12: Recognize that a variety of tools can be used to examine objects at different degrees of magnification (e.g., hand lens, microscope) (SI-E-B3).

b. GLE 13: Explain and give examples of how scientific discoveries have affected society (SI-E-B6).

B. Physical Science: Strand Two

1. Properties of Objects and Materials

a. GLE 14: Classify objects as *bendable* or *rigid* (PS-E-A1).

b. GLE 15: Record the temperature of objects (Celsius and Fahrenheit) (PS-E-A1).

c. GLE 16: Measure weight/mass and volume of a variety of objects and materials by using a pan balance and various containers (PS-E-A2).

d. GLE 17: Use standard tools to measure objects or materials (e.g., ruler, meter stick, measuring tape, pan balance, thermometer, graduated cylinder) (PS-E-A2).

e. GLE 18: Observe, describe, and record the characteristics of materials that make up different objects (e.g., metal, nonmetal, plastic, rock, wood, paper) (PS-E-A3).

f. GLE 19: Describe and illustrate what remains after water evaporates from a salt or sugar solution (PS-E-A5).

2. Position and Motion of Objects

a. GLE 20: Observe and describe differences in motion between objects (e.g., toward/away, cardinal directions) (PS-E-B3).

3. Forms of Energy

a. GLE 21: Use students' own voices to demonstrate pitch (e.g., low, high) (PS-E-C1).

b. GLE 22: Give examples of objects that vibrate to produce sound (e.g., drum, stringed instrument, end of a ruler, cymbal) (PS-E-C1).

c. GLE 23: Change the direction of light by using a mirror and/or lens (PS-E-C2).

d. GLE 24: Describe how light behaves when it strikes objects and materials (e.g., transparent, translucent, opaque) (PS-E-C2).

e. GLE 25: Investigate ways of producing static electricity and describe its effects (PS-E-C4).

f. GLE 26: Identify and describe sources of energy used at school, home, and play (PS-E-C7).

C. Life Science: Strand Three

1. Characteristics of Organisms

a. GLE 27: Match the appropriate food source and habitat for a variety of animals (e.g., cows/grass/field, fish/tadpoles/water) (LS-E-A1).

b. GLE 28: Describe structures of plants (e.g., roots, leaves, stems, flowers, seeds) (LS-E-A3).

c. GLE 29: Compare differences and similarities among a variety of seed plants (LS-E-A3).

d. GLE 30: Identify physical characteristics of organisms (e.g., worms, amphibians, plants) (LS-E-A4).

e. GLE 31: Identify and discuss the arrangement of the food pyramid (LS-E-A6).

f. GLE 32: Analyze selected menus to determine whether they include representatives of all the required food groups (LS-E-A6).

2. Life Cycles of Organisms

a. GLE 33: Compare the life cycles of selected organisms (e.g., mealworm, caterpillar, tadpole) (LS-E-B1).

b. GLE 34: Describe inherited characteristics of living things (LS-E-B3).

3. Organisms and Their Environments

a. GLE 35: Identify the components of a variety of habitats and describe how organisms in those habitats depend on each other (LS-E-C1).

D. Earth and Space Science: Strand Four

1. Properties of Earth Materials

a. GLE 36: Observe and record the properties of rocks, minerals, and soils gathered from their surroundings (e.g., color, texture, odor) (ESS-E-A1).

b. GLE 37: Compare bodies of water found on earth (e.g., oceans, seas, lakes, rivers, glaciers) (ESS-E-A2).

c. GLE 38: Explain why most of the water on earth cannot be used as drinking (potable) water (ESS-E-A2).

d. GLE 39: Design an experiment involving evaporation (ESS-E-A3).

e. GLE 40: Gather, record, and graph weather data (e.g., precipitation, wind speed, wind direction, temperature) using appropriate instruments (ESS-E-A4).

f. GLE 41: Analyze recorded daily temperatures and weather conditions from newspapers, television, the Internet, and home/outdoor thermometers (ESS-E-A4).

g. GLE 42: Identify and use appropriate tools to gather and study rocks, minerals, and fossils (ESS-E-A5).

2. Objects in the Sky

a. GLE 43: Describe characteristics of the sun, stars, and earth's moon (e.g., relative size, shape, color, production of light/heat) (ESS-E-B1).

b. GLE 44: Give examples of how the sun affects earth's processes (e.g., weather, water cycle) (ESS-E-B5).

E. Science and the Environment: Strand Five

1. GLE 45: Locate and identify plants and animals within an ecosystem (SE-E-A2).

2. GLE 46: Illustrate and describe a simple food chain located within an ecosystem (SE-E-A2).

3. GLE 47: Identify the sun as the primary energy source in a food chain (SE-E-A2).

4. GLE 48: Describe a variety of activities related to preserving the environment (SE-E-A3).

5. GLE 49: Describe how consumption of resources can be reduced by recycling, reusing, and conserving (SE-E-A4).

6. GLE 50: Describe ways in which habitat loss or change can occur as a result of natural events or human impact (SE-E-A5).

7. GLE 51: Describe and give examples of threatened or endangered species (SE-E-A5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2782 (November 2005).

§1909. Third Grade

A. Science as Inquiry: Strand One

1. The Abilities to Do Scientific Inquiry

a. GLE 1: Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (SI-E-A1).

b. GLE 2: Pose questions that can be answered by using students' own observations, scientific knowledge, and testable scientific investigations (SI-E-A1).

c. GLE 3: Use observations to design and conduct simple investigations or experiments to answer testable questions (SI-E-A2).

d. GLE 4: Predict and anticipate possible outcomes (SI-E-A2).

e. GLE 5: Use a variety of methods and materials and multiple trials to investigate ideas (observe, measure, accurately record data) (SI-E-A2).

f. GLE 6: Use the five senses to describe observations (SI-E-A3).

g. GLE 7: Measure and record length, temperature, mass, volume, and area in both metric system and U.S. system units (SI-E-A4).

h. GLE 8: Select and use developmentally appropriate equipment and tools (e.g., magnifying lenses, microscopes, graduated cylinders) and units of measurement to observe and collect data (SI-E-A4).

i. GLE 9: Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate (SI-E-A5) (SI-E-B4).

j. GLE 10: Combine information, data, and knowledge from one or more of the science content areas to reach a conclusion or make a prediction (SI-E-A5).

k. GLE 11: Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios) (SI-E-A6).

l. GLE 12: Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties) (SI-E-A7).

2. Understanding Scientific Inquiry

a. GLE 13: Identify questions that need to be explained through further inquiry (SI-E-B1).

b. GLE 14: Distinguish between what is known and what is unknown in scientific investigations (SI-E-B1).

c. GLE 15: Recognize that a variety of tools can be used to examine objects at different degrees of magnification (e.g., hand lens, microscope) (SI-E-B3).

d. GLE 16: Describe procedures and communicate data in a manner that allows others to understand and repeat an investigation or experiment (SI-E-B5).

e. GLE 17: Explain and give examples of how scientific discoveries have affected society (SI-E-B6).

B. Physical Science: Strand Two

1. Properties of Objects and Materials

a. GLE 18: Compare and classify objects on properties determined through experimentation (e.g., ability to conduct electricity, tendency to float or sink in water) (PS-E-A1).

b. GLE 19: Select the appropriate metric system and U.S. system tools for measuring length, width, temperature, volume, and mass (PS-E-A2).

c. GLE 20: Measure temperature by using Fahrenheit and Celsius thermometers and compare results (PS-E-A2).

d. GLE 21: Compare common objects and identify the original material from which they are made (e.g., paper, pencil, comb) (PS-E-A3).

e. GLE 22: Investigate and explain conditions under which matter changes physical states: heating, freezing, evaporating, condensing, boiling (PS-E-A4).

2. Position and Motion of Objects

a. GLE 23: Demonstrate how force is a *push* or a *pull* by using students' bodies, toy cars, or balls (PS-E-B2).

b. GLE 24: Explain how the amount and direction of force exerted on an object (e.g., push, pull, friction, gravity) determine how much the object will move (PS-E-B2).

c. GLE 25: Observe and analyze motion and position of objects over time (e.g., shadows, apparent path of the sun across the sky) (PS-E-B3).

d. GLE 26: Explain the effect of varying amounts of force on the motion of an object (PS-E-B4).

3. Forms of Energy

a. GLE 27: Use the words *high/low* to compare the pitch of sound and the words *loud/soft* to compare the volume (amplitude) of sound (PS-E-C1).

b. GLE 28: Describe the reflection/absorption properties of various colored objects (PS-E-C2).

c. GLE 29: Determine which materials insulate best by using experimental data (PS-E-C3).

d. GLE 30: Demonstrate and explain the movement of electricity in closed and open circuits (PS-E-C4)

e. GLE 31: Compare and describe the common forms of energy and explain how they are used in everyday life (e.g., light, electricity, heat, mechanical) (PS-E-C6).

f. GLE 32: Give examples of how energy can be used to move or lift objects (PS-E-C6).

g. GLE 33: Identify simple machines and the tasks they make possible (PS-E-C6).

C. Life Science: Strand Three

1. Characteristics of Organisms

a. GLE 34: Describe what the human body needs to grow and be healthy (LS-E-A1).

b. GLE 35: Compare structures (parts of the body) in a variety of animals (e.g., fish, mammals, reptiles, amphibians, birds, insects) (LS-E-A3).

c. GLE 36: Compare structures (e.g., roots, leaves, stems, flowers, seeds) and their functions in a variety of plants (LS-E-A3).

d. GLE 37: Describe how plant structures enable the plant to meet its basic needs (LS-E-A3).

e. GLE 38: Classify groups of organisms based on common characteristics (LS-E-A4).

f. GLE 39: Compare organisms from different groups (e.g., birds with mammals, terrestrial plants with aquatic plants) (LS-E-A4).

g. GLE 40: Explain how the organs of the digestive system function (LS-E-A5).

h. GLE 41: Describe how the components of the skeletal system function (LS-E-A5).

i. GLE 42: Describe the relationship between eating habits and maintaining a healthy body (LS-E-A6).

j. GLE 43: Identify a meal that includes representatives from each group of the food pyramid (LS-E-A6).

2. Life Cycles of Organisms

a. GLE 44: Graph, analyze, and interpret personal and class data (LS-E-B4).

D. Earth and Space Science: Strand Four

1. Properties of Earth Materials

a. GLE 45: Recognize and describe that rock is composed of different combinations of minerals (ESS-E-A1) (ESS-E-A5).

b. GLE 46: Describe earth processes that have affected selected physical features in students' neighborhoods (e.g., rusting, weathering, erosion) (ESS-E-A1).

c. GLE 47: Describe the difference between weather and climate (ESS-E-A2).

d. GLE 48: Identify examples of the processes of a water cycle (e.g., evaporation, condensation, precipitation, collection of runoff) (ESS-E-A3).

e. GLE 49: Describe climate patterns from recorded weather conditions over a period of time (ESS-E-A4).

f. GLE 50: Compare and group common rocks according to their characteristics (i.e., igneous, metamorphic, sedimentary) (ESS-E-A5).

g. GLE 51: Identify and compare the components found in soil (ESS-E-A6) (ESS-E-A1).

h. GLE 52: Identify characteristics of selected fossils and explain how fossil records are used to learn about the past (ESS-E-A7).

2. Objects in the Sky

a. GLE 53: Identify, in order, the planets of the solar system (ESS-E-B1).

b. GLE 54: Describe the patterns of apparent change in the position of the sun (ESS-E-B2).

c. GLE 55: Explain the results of the rotation and revolution of earth (e.g., day and night, year) (ESS-E-B4).

d. GLE 56: Compare shadow direction and length at different times of day and year (ESS-E-B4).

E. Science and the Environment: Strand Five

1. GLE 57: Describe the interrelationships of *living (biotic)* and *nonliving (abiotic)* components within various ecosystems (e.g., terrarium, swamp, backyard) (SE-E-A1).

2. GLE 58: Describe how humans have had negative and positive effects on organisms and their environments (SE-E-A3) (SE-E-A5).

3. GLE 59: Classify manufactured products according to the natural resources from which they are made (e.g., copper wire from copper ore, plastic from petroleum) (SE-E-A4).

4. GLE 60: Explain how renewable and nonrenewable resources can be replenished or depleted (SE-E-A4).

5. GLE 61: Explain how selected animals once classified as endangered have recovered (SE-E-A5).

6. GLE 62: Identify animals in Louisiana that have recovered and that are no longer considered endangered (SE-E-A5).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2784 (November 2005).

§1911. Fourth Grade

A. Science as Inquiry: Strand One

1. The Abilities to Do Scientific Inquiry

a. GLE 1: Ask questions about objects and events in the environment (e.g., plants, rocks, storms) (SI-E-A1).

b. GLE 2: Pose questions that can be answered by using students' own observations, scientific knowledge, and testable scientific investigations (SI-E-A1).

c. GLE 3: Use observations to design and conduct simple investigations or experiments to answer testable questions (SI-E-A2).

d. GLE 4: Predict and anticipate possible outcomes (SI-E-A2).

e. GLE 5: Identify variables to ensure that only one experimental variable is tested at a time (SI-E-A2).

f. GLE 6: Use a variety of methods and materials and multiple trials to investigate ideas (observe, measure, accurately record data) (SI-E-A2).

g. GLE 7: Use the five senses to describe observations (SI-E-A3).

h. GLE 8: Measure and record length, temperature, mass, volume, and area in both metric system and U.S. system units (SI-E-A4).

i. GLE 9: Select and use developmentally appropriate equipment and tools (e.g., magnifying lenses, microscopes, graduated cylinders) and units of measurement to observe and collect data (SI-E-A4).

j. GLE 10: Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate (SI-E-A5) (SI-E-B4).

k. GLE 11: Combine information, data, and knowledge from one or more of the science content areas to reach a conclusion or make a prediction (SI-E-A5).

l. GLE 12: Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios) (SI-E-A6).

m. GLE 13: Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties) (SI-E-A7).

2. Understanding Scientific Inquiry

a. GLE 14: Identify questions that need to be explained through further inquiry (SI-E-B1).

b. GLE 15: Distinguish between what is known and what is unknown in scientific investigations (SI-E-B1).

c. GLE 16: Select the best experimental design to answer a given testable question (SI-E-B2).

d. GLE 17: Recognize that a variety of tools can be used to examine objects at different degrees of magnification (e.g., hand lens, microscope) (SI-E-B3).

e. GLE 18: Base explanations and logical inferences on scientific knowledge, observations, and scientific evidence (SI-E-B4).

f. GLE 19: Describe procedures and communicate data in a manner that allows others to understand and repeat an investigation or experiment (SI-E-B5).

g. GLE 20: Determine whether further investigations are needed to draw valid conclusions (SI-E-B6).

h. GLE 21: Use evidence from previous investigations to ask additional questions and to initiate further explorations (SI-E-B6).

i. GLE 22: Explain and give examples of how scientific discoveries have affected society (SI-E-B6).

B. Physical Science: Strand Two

1. Properties of Objects and Materials

a. GLE 23: Determine linear, volume, and weight/mass measurements by using both metric system and U.S. system units to compare the results (PS-E-A2).

b. GLE 24: Illustrate how heating/cooling affects the motion of small particles in different phases of matter (PS-E-A4).

c. GLE 25: Describe various methods to separate mixtures (e.g., evaporation, condensation, filtration, magnetism) (PS-E-A5).

2. Position and Motion of Objects

a. GLE 26: Measure, record, and graph changes in position over time (e.g., speed of cars, ball rolling down inclined plane) (PS-E-B3).

b. GLE 27: Describe how the amount of force needed to cause an object to change its motion depends on the mass of the object (PS-E-B4).

3. Forms of Energy

a. GLE 28: Explain the relationship between volume (amplitude) of sound and energy required to produce the sound (PS-E-C1).

b. GLE 29: Compare the rates at which sound travels through solids, liquids, and gases (PS-E-C1).

c. GLE 30: Explain the relationship between frequency (rate of vibration) and pitch (PS-E-C1).

d. GLE 31: Diagram what happens to white light as it passes through a prism (PS-E-C2).

e. GLE 32: Describe how light bends or refracts when traveling through various materials (e.g., pencil in a glass of water) (PS-E-C2).

f. GLE 33: Describe how heat energy moves through a material by conduction (PS-E-C3).

g. GLE 34: Give examples of ways heat can be generated through friction (e.g., rubbing hands) (PS-E-C3).

h. GLE 35: Give examples of ways heat can be produced by conversion from other sources of energy (PS-E-C3).

i. GLE 36: Test and classify materials as *conductors* and *insulators* of electricity (PS-E-C4).

j. GLE 37: Demonstrate how a complete circuit is needed for conducting electricity (PS-E-C4).

k. GLE 38: Explain the effects of earth's gravity on all objects at or near the surface of earth (PS-E-C5).

l. GLE 39: Describe energy transformations (e.g., electricity to light, friction to heat) (PS-E-C6).

C. Life Science: Strand Three

1. Characteristics of Organisms

a. GLE 40: Explain the functions of plant structures in relation to their ability to make food through photosynthesis (e.g., roots, leaves, stems, flowers, seeds) (LS-E-A3).

b. GLE 41: Describe how parts of animals' bodies are related to their functions and survival (e.g., wings/flying, webbed feet/swimming) (LS-E-A3).

c. GLE 42: Describe how the organs of the circulatory and respiratory systems function (LS-E-A5).

d. GLE 43: Explain the primary role of carbohydrates, fats, and proteins in the body (LS-E-A6).

e. GLE 44: Analyze food labels to compare nutritional content of foods (e.g., amounts of carbohydrates, fats, proteins) (LS-E-A6).

2. Life Cycles of Organisms

a. GLE 45: Identify reproductive structures in plants and describe the functions of each (LS-E-B1).

b. GLE 46: Describe how some plants can be grown from a plant part instead of a seed (LS-E-B1).

c. GLE 47: Sequence stages in the life cycles of various organisms, including seed plants (LS-E-B1).

d. GLE 48: Classify examples of plants and animals based on a variety of criteria (LS-E-B2).

e. GLE 49: Compare similarities and differences between parents and offspring in plants and animals (LS-E-B3).

3. Organisms and Their Environments

a. GLE 50: Explain how some organisms in a given habitat compete for the same resources (LS-E-C1).

b. GLE 51: Describe how organisms can modify their environment to meet their needs (e.g., beavers making dams) (LS-E-C1).

c. GLE 52: Describe how some plants and animals have adapted to their habitats (LS-E-C2).

d. GLE 53: Identify the habitat in which selected organisms would most likely live and explain how specific structures help organisms to survive (LS-E-C2).

e. GLE 54: Describe the effect of sudden increases or decreases of one group of organisms upon other organisms in the environment (LS-E-C3).

D. Earth and Space Science: Strand Four

1. Properties of Earth Materials

a. GLE 55: Recognize that sedimentary rocks are composed of particles that result from weathering and erosion (e.g., sandstones, conglomerates) (ESS-E-A1).

b. GLE 56: Investigate the properties of soil (e.g., color, texture, capacity to retain water, ability to support plant growth) (ESS-E-A1).

c. GLE 57: Explain how unequal heating of earth's land and water affects climate and weather by using a model (ESS-E-A2).

d. GLE 58: Draw, label, and explain the components of a water cycle (ESS-E-A3).

e. GLE 59: Measure, chart, and predict the weather using various instruments (e.g., thermometer, barometer, anemometer) (ESS-E-A4).

f. GLE 60: Identify various types of weather-related natural hazards and effects (e.g., lightning, storms) (ESS-E-A4).

g. GLE 61: Identify safety measures applicable to natural hazards (ESS-E-A4).

h. GLE 62: Classify rocks and minerals according to texture, color, luster, hardness, and effervescence (ESS-E-A5).

i. GLE 63: Demonstrate and explain how earth's surface is changed as a result of slow and rapid processes (e.g., sand dunes, canyons, volcanoes, earthquakes) (ESS-E-A5) (ESS-E-A1).

2. Objects in the Sky

a. GLE 64: Describe and sequence the phases of the moon and eclipses (ESS-E-B2).

b. GLE 65: Compare a solar and a lunar eclipse (ESS-E-B2).

c. GLE 66: Diagram the movement of the moon around earth and the movement of earth around the sun (ESS-E-B2).

d. GLE 67: Explain the changing appearance of the moon and its location in the sky over the course of a month (ESS-E-B3).

e. GLE 68: Identify the relationship between earth's tilt and revolution and the seasons (ESS-E-B4).

f. GLE 69: Explain how technology has improved our knowledge of the universe (e.g., Hubble telescope, space stations, lunar exploration) (ESS-E-B6).

E. Science and the Environment: Strand Five

1. GLE 70: Design an ecosystem that includes *living* (biotic) and *nonliving* (abiotic) components and illustrates interdependence (SE-E-A1).

2. GLE 71: Describe and explain food chains/webs and the directional flow of energy in various ecosystems (e.g., construct a model, drawing, diagram, graphic organizer) (SE-E-A2).

3. GLE 72: Predict and describe consequences of the removal of one component in a balanced ecosystem (e.g., consumer, herbivores, nonliving component) (SE-E-A2).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2785 (November 2005).

§1913. Fifth Grade

A. Science as Inquiry: Strand One

1. The Abilities to Do Scientific Inquiry

a. GLE 1: Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1).

b. GLE 2: Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1).

c. GLE 3: Use a variety of sources to answer questions (SI-M-A1).

d. GLE 4: Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2).

e. GLE 5: Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2).

f. GLE 6: Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3).

g. GLE 7: Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3).

h. GLE 8: Use consistency and precision in data collection, analysis, and reporting (SI-M-A3).

i. GLE 9: Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3).

j. GLE 10: Identify the difference between description and explanation (SI-M-A4).

k. GLE 11: Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4).

l. GLE 12: Use data and information gathered to develop an explanation of experimental results (SI-M-A4).

m. GLE 13: Identify patterns in data to explain natural events (SI-M-A4).

n. GLE 14: Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5).

o. GLE 15: Identify and explain the limitations of models used to represent the natural world (SI-M-A5).

p. GLE 16: Use evidence to make inferences and predict trends (SI-M-A5).

q. GLE 17: Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6).

r. GLE 18: Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6).

s. GLE 19: Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets,

concept maps, oral and written reports, equations) (SI-M-A7).

t. GLE 20: Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7).

u. GLE 21: Distinguish between *observations* and *inferences* (SI-M-A7).

v. GLE 22: Use evidence and observations to explain and communicate the results of investigations (SI-M-A7).

w. GLE 23: Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8).

x. GLE 24: Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8).

2. Understanding Scientific Inquiry

a. GLE 25: Compare and critique scientific investigations (SI-M-B1).

b. GLE 26: Use and describe alternate methods for investigating different types of testable questions (SI-M-B1).

c. GLE 27: Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1).

d. GLE 28: Recognize that investigations generally begin with a review of the work of others (SI-M-B2).

e. GLE 29: Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3).

f. GLE 30: Describe why all questions cannot be answered with present technologies (SI-M-B3).

g. GLE 31: Recognize that there is an acceptable range of variation in collected data (SI-M-B3).

h. GLE 32: Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3).

i. GLE 33: Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4).

j. GLE 34: Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5).

k. GLE 35: Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5).

l. GLE 36: Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5).

m. GLE 37: Critique and analyze their own inquiries and the inquiries of others (SI-M-B5).

n. GLE 38: Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6).

o. GLE 39: Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7).

p. GLE 40: Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7).

B. Physical Science: Strand Two

1. Properties and Changes of Properties in Matter

a. GLE 1: Measure a variety of objects in metric system units (PS-M-A1).

b. GLE 2: Compare the physical properties of large and small quantities of the same type of matter (PS-M-A1).

c. GLE 3: Describe the structure of atoms and the electrical charge of protons, neutrons, and electrons (PS-M-A2).

d. GLE 4: Identify the physical and chemical properties of various substances and group substances according to their observable and measurable properties (e.g., conduction, magnetism, light transmission) (PS-M-A3).

e. GLE 5: Describe the properties and behavior of water in its solid, liquid, and gaseous phases (states) (PS-M-A5).

f. GLE 6: Describe new substances formed from common chemical reactions (e.g., burning paper produces ash) (PS-M-A6).

2. Motions and Forces

a. GLE 7: Compare, calculate, and graph the average speeds of objects in motion using both metric system and U.S. system units (PS-M-B1).

b. GLE 8: Explain that gravity accelerates all falling objects at the same rate in the absence of air resistance (PS-M-B3).

c. GLE 9: Demonstrate a change in speed or direction of an object's motion with the use of unbalanced forces (PS-M-B5).

3. Transformations of Energy

a. GLE 10: Compare potential and kinetic energy and give examples of each (PS-M-C1).

b. GLE 11: Classify energy resources as *renewable*, *non-renewable*, or *inexhaustible* (PS-M-C1).

c. GLE 12: Identify the sun as earth's primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion (PS-M-C3).

d. GLE 13: Investigate how changes in the position of a light source and an object alter the size and shape of the shadow (PS-M-C4).

e. GLE 14: Identify other types of energy produced through the use of electricity (e.g., heat, light, mechanical) (PS-M-C6).

C. Life Science: Strand Three

1. Structure and Function in Living Systems

a. GLE 15: Identify the cell as the basic unit of living things (LS-M-A1).

b. GLE 16: Observe, identify, and describe the basic components of cells and their functions (e.g., cell wall, cell membrane, cytoplasm, nucleus) (LS-M-A1).

c. GLE 17: Compare plant and animal cells and label cell components (LS-M-A2).

d. GLE 18: Describe the metamorphosis of an amphibian (e.g., frog) (LS-M-A3).

e. GLE 19: Describe the processes of photosynthesis and respiration in green plants (LS-M-A4).

f. GLE 20: Describe the levels of structural organization in living things (e.g., cells, tissues, organs, organ systems) (LS-M-A5).

g. GLE 21: Identify diseases caused by germs and how they can be transmitted from person to person (LS-M-A7).

2. Populations and Ecosystems

a. GLE 22: Develop and use a simple dichotomous key to classify common plants and animals (LS-M-C1).

b. GLE 23: Construct food chains that could be found in ponds, marshes, oceans, forests, or meadows (LS-M-C2).

c. GLE 24: Describe the roles of producers, consumers, and decomposers in a food chain (LS-M-C2).

d. GLE 25: Compare food chains and food webs (LS-M-C2).

e. GLE 26: Identify and describe ecosystems of local importance (LS-M-C3).

f. GLE 27: Compare common traits of organisms within major ecosystems (LS-M-C3).

g. GLE 28: Explain and give examples of predator/prey relationships (LS-M-C4).

3. Adaptations of Organisms

a. GLE 29: Describe adaptations of plants and animals that enable them to thrive in local and other natural environments (LS-M-D1).

D. Earth and Space Science: Strand Four

1. Structure of the Earth

a. GLE 30: Identify organic and inorganic matter in soil samples with the aid of a hand lens or microscope (ESS-M-A4).

b. GLE 31: Identify common rocks and minerals and explain their uses and economic significance (ESS-M-A5).

c. GLE 32: Demonstrate the results of constructive and destructive forces using models or illustrations (ESS-M-A7).

d. GLE 33: Identify the processes that prevent or cause erosion (ESS-M-A7).

e. GLE 34: Identify the components of the hydrosphere (ESS-M-A11).

f. GLE 35: Identify the atmosphere as a mixture of gases, water vapor, and particulate matter (ESS-M-A11).

g. GLE 36: Identify, describe, and compare climate zones (e.g., polar, temperate, tropical) (ESS-M-A11).

h. GLE 37: Identify typical weather map symbols and the type of weather they represent (ESS-M-A12).

2. Earth History

a. GLE 38: Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (ESS-M-B3).

3. Earth in the Solar System

a. GLE 39: Identify the physical characteristics of the sun (ESS-M-C1).

b. GLE 40: Describe the significance of Polaris as the North Star (ESS-M-C1).

c. GLE 41: Explain why the moon, sun, and stars appear to move from east to west across the sky (ESS-M-C1).

d. GLE 42: Differentiate among moons, asteroids, comets, meteoroids, meteors, and meteorites (ESS-M-C2).

e. GLE 43: Describe the characteristics of the inner and outer planets (ESS-M-C2).

f. GLE 44: Explain rotation and revolution by using models or illustrations (ESS-M-C4).

g. GLE 45: Identify earth's position in the solar system (ESS-M-C5).

h. GLE 46: Identify and explain the interaction of the processes of the water cycle (ESS-M-C6) (ESS-M-A10).

i. GLE 47: Identify and explain advances in technology that have enabled the exploration of space (ESS-M-C8).

E. Science and the Environment: Strand Five

1. GLE 48: Determine the ability of an ecosystem to support a population (carrying capacity) by identifying the resources needed by that population (SE-M-A2).

2. GLE 49: Identify and give examples of pollutants found in water, air, and soil (SE-M-A3).

3. GLE 50: Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species) (SE-M-A4).

4. GLE 51: Describe naturally occurring cycles and identify where they are found (e.g., carbon, nitrogen, water, oxygen) (SE-M-A7).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2787 (November 2005).

§1915. Middle School: Grades 5-8

A. Science as Inquiry: Strand One

1. The Abilities Necessary to Do Scientific Inquiry

a. GLE 1: Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1).

b. GLE 2: Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1).

c. GLE 3: Use a variety of sources to answer questions (SI-M-A1).

d. GLE 4: Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2).

e. GLE 5: Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2).

f. GLE 6: Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3).

g. GLE 7: Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3).

h. GLE 8: Use consistency and precision in data collection, analysis, and reporting (SI-M-A3).

i. GLE 9: Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3).

j. GLE 10: Identify the difference between description and explanation (SI-M-A4).

k. GLE 11: Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4).

l. GLE 12: Use data and information gathered to develop an explanation of experimental results (SI-M-A4).

m. GLE 13: Identify patterns in data to explain natural events (SI-M-A4).

n. GLE 14: Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5).

o. GLE 15: Identify and explain the limitations of models used to represent the natural world (SI-M-A5).

p. GLE 16: Use evidence to make inferences and predict trends (SI-M-A5).

q. GLE 17: Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6).

r. GLE 18: Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6).

s. GLE 19: Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7).

t. GLE 20: Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7).

u. GLE 21: Distinguish between *observations* and *inferences* (SI-M-A7).

v. GLE 22: Use evidence and observations to explain and communicate the results of investigations (SI-M-A7).

w. GLE 23: Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8).

x. GLE 24: Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8).

2. Understanding Scientific Inquiry

a. GLE 25: Compare and critique scientific investigations (SI-M-B1).

b. GLE 26: Use and describe alternate methods for investigating different types of testable questions (SI-M-B1).

c. GLE 27: Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1).

d. GLE 28: Recognize that investigations generally begin with a review of the work of others (SI-M-B2).

e. GLE 29: Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3).

f. GLE 30: Describe why all questions cannot be answered with present technologies (SI-M-B3).

g. GLE 31: Recognize that there is an acceptable range of variation in collected data (SI-M-B3).

h. GLE 32: Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3).

i. GLE 33: Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4).

j. GLE 34: Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5).

k. GLE 35: Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5).

l. GLE 36: Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5).

m. GLE 37: Critique and analyze their own inquiries and the inquiries of others (SI-M-B5).

n. GLE 38: Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6).

o. GLE 39: Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7).

p. GLE 40: Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17.6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2789 (November 2005).

§1917. Grade 5

A. Physical Science: Strand Two

1. Properties and Changes of Properties in Matter

a. GLE 1: Measure a variety of objects in metric system units (PS-M-A1).

b. GLE 2: Compare the physical properties of large and small quantities of the same type of matter (PS-M-A1).

c. GLE 3: Describe the structure of atoms and the electrical charge of protons, neutrons, and electrons (PS-M-A2).

d. GLE 4: Identify the physical and chemical properties of various substances and group substances according to their observable and measurable properties (e.g., conduction, magnetism, light transmission) (PS-M-A3).

e. GLE 5: Describe the properties and behavior of water in its solid, liquid, and gaseous phases (states) (PS-M-A5).

f. GLE 6: Describe new substances formed from common chemical reactions (e.g., burning paper produces ash) (PS-M-A6).

2. Motions and Forces

a. GLE 7: Compare, calculate, and graph the average speeds of objects in motion using both metric system and U.S. system units (PS-M-B1).

b. GLE 8: Explain that gravity accelerates all falling objects at the same rate in the absence of air resistance (PS-M-B3).

c. GLE 9: Demonstrate a change in speed or direction of an object's motion with the use of unbalanced forces (PS-M-B5).

3. Transformations of Energy

a. GLE 10: Compare potential and kinetic energy and give examples of each (PS-M-C1).

b. GLE 11: Classify energy resources as *renewable*, *non-renewable*, or *inexhaustible* (PS-M-C1).

c. GLE 12: Identify the sun as earth's primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion (PS-M-C3).

d. GLE 13: Investigate how changes in the position of a light source and an object alter the size and shape of the shadow (PS-M-C4).

e. GLE 14: Identify other types of energy produced through the use of electricity (e.g., heat, light, mechanical) (PS-M-C6).

B. Life Science: Strand Three

1. Structure and Function in Living Systems

a. GLE 15: Identify the cell as the basic unit of living things (LS-M-A1).

b. GLE 16: Observe, identify, and describe the basic components of cells and their functions (e.g., cell wall, cell membrane, cytoplasm, nucleus) (LS-M-A1).

c. GLE 17: Compare plant and animal cells and label cell components (LS-M-A2).

d. GLE 18: Describe the metamorphosis of an amphibian (e.g., frog) (LS-M-A3).

e. GLE 19: Describe the processes of photosynthesis and respiration in green plants (LS-M-A4).

f. GLE 20: Describe the levels of structural organization in living things (e.g., cells, tissues, organs, organ systems) (LS-M-A5).

g. GLE 21: Identify diseases caused by germs and how they can be transmitted from person to person (LS-M-A7).

2. Populations and Ecosystems

a. GLE 22: Develop and use a simple dichotomous key to classify common plants and animals (LS-M-C1).

b. GLE 23: Construct food chains that could be found in ponds, marshes, oceans, forests, or meadows (LS-M-C2).

c. GLE 24: Describe the roles of producers, consumers, and decomposers in a food chain (LS-M-C2).

d. GLE 25: Compare food chains and food webs (LS-M-C2).

e. GLE 26: Identify and describe ecosystems of local importance (LS-M-C3).

f. GLE 27: Compare common traits of organisms within major ecosystems (LS-M-C3).

g. GLE 28: Explain and give examples of predator/prey relationships (LS-M-C4).

3. Adaptations of Organisms

a. GLE 29: Describe adaptations of plants and animals that enable them to thrive in local and other natural environments (LS-M-D1).

C. Earth and Space Science: Strand Four

1. Structure of Earth

a. GLE 30: Identify organic and inorganic matter in soil samples with the aid of a hand lens or microscope (ESS-M-A4).

b. GLE 31: Identify common rocks and minerals and explain their uses and economic significance (ESS-M-A5).

c. GLE 32: Demonstrate the results of constructive and destructive forces using models or illustrations (ESS-M-A7).

d. GLE 33: Identify the processes that prevent or cause erosion (ESS-M-A7).

e. GLE 34: Identify the components of the hydrosphere (ESS-M-A11).

f. GLE 35: Identify the atmosphere as a mixture of gases, water vapor, and particulate matter (ESS-M-A11).

g. GLE 36: Identify, describe, and compare climate zones (e.g., polar, temperate, tropical) (ESS-M-A11).

h. GLE 37: Identify typical weather map symbols and the type of weather they represent (ESS-M-A12).

2. Earth History

a. GLE 38: Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (ESS-M-B3).

3. Earth in the Solar System

a. GLE 39: Identify the physical characteristics of the sun (ESS-M-C1).

b. GLE 40: Describe the significance of Polaris as the North Star (ESS-M-C1).

c. GLE 41: Explain why the moon, sun, and stars appear to move from east to west across the sky (ESS-M-C1).

d. GLE 42: Differentiate among moons, asteroids, comets, meteoroids, meteors, and meteorites (ESS-M-C2).

e. GLE 43: Describe the characteristics of the inner and outer planets (ESS-M-C2).

f. GLE 44: Explain rotation and revolution by using models or illustrations (ESS-M-C4).

g. GLE 45: Identify earth's position in the solar system (ESS-M-C5).

h. GLE 46: Identify and explain the interaction of the processes of the water cycle (ESS-M-C6) (ESS-M-A10).

i. GLE 47: Identify and explain advances in technology that have enabled the exploration of space (ESS-M-C8).

D. Science and the Environment: Strand Five

1. GLE 48: Determine the ability of an ecosystem to support a population (carrying capacity) by identifying the resources needed by that population (SE-M-A2).

2. LE 49: Identify and give examples of pollutants found in water, air, and soil (SE-M-A3).

3. GLE 50: Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species) (SE-M-A4).

4. GLE 51: Describe naturally occurring cycles and identify where they are found (e.g., carbon, nitrogen, water, oxygen) (SE-M-A7).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2790 (November 2005).

§1919. Grade 6

A. Physical Science: Strand Two

1. Properties and Changes of Properties in Matter

a. GLE 1: Measure and record the volume and mass of substances in metric system units (PS-M-A1).

b. GLE 2: Calculate the density of large and small quantities of a variety of substances (e.g., aluminum foil, water, copper, clay, rock) (PS-M-A1).

c. GLE 3: Construct models that replicate atomic structure for selected common elements from the periodic table (PS-M-A2).

d. GLE 4: Differentiate between the physical and chemical properties of selected substances (PS-M-A3).

e. GLE 5: Compare physical and chemical changes (PS-M-A3).

f. GLE 6: Draw or model the movement of atoms in solid, liquid, and gaseous states (PS-M-A4).

g. GLE 7: Simulate how atoms and molecules have kinetic energy exhibited by constant motion (PS-M-A4).

h. GLE 8: Determine the temperatures at which water changes physical phases (e.g., freezing point, melting point, boiling point) (PS-M-A5).

i. GLE 9: Describe the properties of reactants and products of chemical reactions observed in the lab (PS-M-A6).

j. GLE 10: Identify the average atomic masses of given elements using the periodic table (PS-M-A7).

k. GLE 11: Compare the masses of reactants and products of a chemical reaction (PS-M-A7).

l. GLE 12: Determine the effect of particle size of the same reactants on the rate of chemical reactions during a lab activity (e.g., powdered vs. solid forms) (PS-M-A8).

m. GLE 13: Use a variety of resources to identify elements and compounds in common substances (PS-M-A9).

2. Motions and Forces

a. GLE 14: Construct and analyze graphs that represent one-dimensional motion (i.e., motion in a straight line) and predict the future positions and speed of a moving object (PS-M-B1).

b. GLE 15: Explain why velocity is expressed in both speed and direction (PS-M-B1).

c. GLE 16: Compare line graphs of acceleration, constant speed, and deceleration (PS-M-B1).

d. GLE 17: Describe and demonstrate that friction is a force that acts whenever two surfaces or objects move past one another (PS-M-B2).

e. GLE 18: Explain how the resistance of materials affects the rate of electrical flow (PS-M-B2).

f. GLE 19: Identify forces acting on all objects (PS-M-B3).

g. GLE 20: Draw and label a diagram to represent forces acting on an object (PS-M-B4).

h. GLE 21: Determine the magnitude and direction of unbalanced (i.e., net) forces acting on an object (PS-M-B4).

i. GLE 22: Demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not subjected to an unbalanced force (PS-M-B5) (PS-M-B3).

j. GLE 23: Predict the direction of a force applied to an object and how it will change the speed and direction of the object (PS-M-B5).

3. Transformations of Energy

a. GLE 24: Describe and give examples of how all forms of energy may be classified as potential or kinetic energy (PS-M-C1).

b. GLE 25: Compare forms of energy (e.g., light, heat, sound, electrical, nuclear, mechanical) (PS-M-C1).

c. GLE 26: Describe and summarize observations of the transmission, reflection, and absorption of sound, light, and heat energy (PS-M-C1).

d. GLE 27: Explain the relationship between work input and work output by using simple machines (PS-M-C2).

e. GLE 28: Explain the law of conservation of energy (PS-M-C2).

f. GLE 29: Compare and/or investigate the relationships among work, power, and efficiency (PS-M-C2).

g. GLE 30: Trace energy transformations in a simple system (e.g., flashlight) (PS-M-C2).

h. GLE 31: Compare types of electromagnetic waves (PS-M-C3).

i. GLE 32: Identify and illustrate key characteristics of waves (e.g., wavelength, frequency, amplitude) (PS-M-C4).

j. GLE 33: Predict the direction in which light will refract when it passes from one transparent material to another (e.g., from air to water, from prism to air) (PS-M-C4).

k. GLE 34: Apply the law of reflection and law of refraction to demonstrate everyday phenomena (e.g., how light is reflected from tinted windows, how light is refracted by cameras, telescopes, eyeglasses) (PS-M-C4).

l. GLE 35: Determine through experimentation whether light is reflected, transmitted, and/or absorbed by a given object or material (PS-M-C4).

m. GLE 36: Explain the relationship between an object's color and the wavelength of light reflected or transmitted to the viewer's eyes (PS-M-C4).

n. GLE 37: Compare how heat is transferred by conduction, convection, and radiation (PS-M-C5).

o. GLE 38: Identify conditions under which thermal energy tends to flow from a system of higher energy to a system of lower energy (PS-M-C5).

p. GLE 39: Describe how electricity can be produced from other types of energy (e.g., magnetism, solar, mechanical) (PS-M-C6).

q. GLE 40: Identify heat energy gains and losses during exothermic and endothermic chemical reactions (PS-M-C7).

r. GLE 41: Identify risks associated with the production and use of coal, petroleum, hydroelectricity, nuclear energy, and other energy forms (PS-M-C8).

B. Science and the Environment: Strand Five

1. GLE 42: Identify energy types from their source to their use and determine if the energy types are renewable, nonrenewable, or inexhaustible (SE-M-A6).

2. GLE 43: Explain how the use of different energy resources affects the environment and the economy (SE-M-A6).

3. GLE 44: Explain how an inexhaustible resource can be harnessed for energy production (SE-M-A6).

4. GLE 45: Describe methods for sustaining renewable resources (SE-M-A6).

5. GLE 46: Identify ways people can reuse, recycle, and reduce the use of resources to improve and protect the quality of life (SE-M-A6).

6. GLE 47: Illustrate how various technologies influence resource use in an ecosystem (e.g., forestry management, soil conservation, fishery improvement) (SE-M-A8).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2791 (November 2005).

§1921. Grade 7

A. Physical Science: Strand Two

1. Properties and Changes of Properties in Matter

a. GLE 1: Identify the elements most often found in living organisms (e.g., C, N, H, O, P, S, Ca, Fe) (PS-M-A9).

B. Life Science: Strand Three

1. Structure and Function in Living Systems

a. GLE 2: Compare the basic structures and functions of different types of cells (LS-M-A1).

b. GLE 3: Illustrate and demonstrate osmosis and diffusion in cells (LS-M-A1).

c. GLE 4: Compare functions of plant and animal cell structures (i.e., organelles) (LS-M-A2).

d. GLE 5: Compare complete and incomplete metamorphosis in insects (e.g., butterflies, mealworms, grasshoppers) (LS-M-A3).

e. GLE 6: Compare the life cycles of a variety of organisms, including non-flowering and flowering plants, reptiles, birds, amphibians, and mammals (LS-M-A3).

f. GLE 7: Construct a word equation that illustrates the processes of photosynthesis and respiration (LS-M-A4).

g. GLE 8: Distinguish between *aerobic* respiration and *anaerobic* respiration (LS-M-A4).

h. GLE 9: Relate structural features of organs to their functions in major systems (LS-M-A5).

i. GLE 10: Describe the way major organ systems in the human body interact to sustain life (LS-M-A5).

j. GLE 11: Describe the growth and development of humans from infancy to old age (LS-M-A6).

k. GLE 12: Explain how external factors and genetics can influence the quality and length of human life (e.g., nutrition, smoking, drug use, exercise) (LS-M-A6).

l. GLE 13: Identify and describe common communicable and noncommunicable diseases and the methods by which they are transmitted, treated, and prevented (LS-M-A7).

2. Reproduction and Heredity

a. GLE 14: Differentiate between sexual and asexual reproduction (LS-M-B1).

b. GLE 15: Contrast the processes of mitosis and meiosis in relation to growth, repair, reproduction, and heredity (LS-M-B1).

c. GLE 16: Explain why chromosomes in body cells exist in pairs (LS-M-B2).

d. GLE 17: Explain the relationship of genes to chromosomes and genotypes to phenotypes (LS-M-B2).

e. GLE 18: Recognize genetic errors caused by changes in chromosomes (LS-M-B2).

f. GLE 19: Apply the basic laws of Mendelian genetics to solve simple monohybrid crosses, using a Punnett square (LS-M-B3).

g. GLE 20: Explain the differences among the inheritance of dominant, recessive, and incomplete dominant traits (LS-M-B3).

h. GLE 21: Use a Punnett square to demonstrate how sex-linked traits are inherited (LS-M-B3).

i. GLE 22: Give examples of the importance of selective breeding (e.g., domestic animals, livestock, horticulture) (LS-M-B3).

3. Populations and Ecosystems

a. GLE 23: Classify organisms based on structural characteristics, using a dichotomous key (LS-M-C1).

b. GLE 24: Analyze food webs to determine energy transfer among organisms (LS-M-C2).

c. GLE 25: Locate and describe the major biomes of the world (LS-M-C3).

d. GLE 26: Describe and compare the levels of organization of living things within an ecosystem (LS-M-C3).

e. GLE 27: Identify the various relationships among plants and animals (e.g., mutualistic, parasitic, producer/consumer) (LS-M-C4).

f. GLE 28: Differentiate between ecosystem components of habitat and niche (LS-M-C4).

g. GLE 29: Predict the impact changes in a species' population have on an ecosystem (LS-M-C4).

4. Adaptations of Organisms

- a. GLE 30: Differentiate between structural and behavioral adaptations in a variety of organisms (LS-M-D1).
- b. GLE 31: Describe and evaluate the impact of introducing nonnative species into an ecosystem (LS-M-D1).
- c. GLE 32: Describe changes that can occur in various ecosystems and relate the changes to the ability of an organism to survive (LS-M-D2).
- d. GLE 33: Illustrate how variations in individual organisms within a population determine the success of the population (LS-M-D2).
- e. GLE 34: Explain how environmental factors impact survival of a population (LS-M-D2).

C. Science and the Environment: Strand Five

- 1. GLE 35: Identify resources humans derive from ecosystems (SE-M-A1).
- 2. GLE 36: Distinguish the essential roles played by biotic and abiotic components in various ecosystems (SE-M-A1).
- 3. GLE 37: Identify and describe the effects of limiting factors on a given population (SE-M-A2).
- 4. GLE 38: Evaluate the carrying capacity of an ecosystem (SE-M-A2).
- 5. GLE 39: Analyze the consequences of human activities on ecosystems (SE-M-A4).
- 6. GLE 40: Construct or draw food webs for various ecosystems (SE-M-A5).
- 7. GLE 41: Describe the nitrogen cycle and explain why it is important for the survival of organisms (SE-M-A7).
- 8. GLE 42: Describe how photosynthesis and respiration relate to the carbon cycle (SE-M-A7).
- 9. GLE 43: Identify and analyze the environmental impact of humans' use of technology (e.g., energy production, agriculture, transportation, human habitation) (SE-M-A8).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6; R.S. 17:24.4; R.S. 17:154.

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2792 (November 2005).

§1923. Grade 8

A. Physical Science: Strand Two

- 1. Properties and Changes of Properties in Matter
 - a. GLE 1: Determine that all atoms of the same element are similar to but different from atoms of other elements (PS-M-A2).
 - b. GLE 2: Recognize that elements with the same number of protons may or may not have the same charge (PS-M-A2).

- c. GLE 3: Define ions and describe them in terms of the number of protons, electrons, and their charges (PS-M-A2).

2. Motions and Forces

- a. GLE 4: Demonstrate that earth has a magnetic field by using magnets and compasses (PS-M-B2).
- b. GLE 5: Define gravity and describe the relationship among the force of gravity, the mass of objects, and the distance between objects (PS-M-B2).
- c. GLE 6: Predict how the gravitational attraction between two masses will increase or decrease when changes are made in the masses or in the distance between the objects (PS-M-B2).
- d. GLE 7: Explain the relationships among force, mass, and acceleration (PS-M-B5).

B. Earth and Space Science: Strand Four

1. Structure of Earth

- a. GLE 8: Identify and describe the four density layers of earth (ESS-M-A1).
- b. GLE 9: Explain the historical development of the theories of plate tectonics, including continental drift and sea-floor spreading (ESS-M-A2).
- c. GLE 10: Illustrate the movement of convection currents (ESS-M-A2).
- d. GLE 11: Illustrate the movements of lithospheric plates as stated in the plate tectonics theory (ESS-M-A2).
- e. GLE 12: Identify the edges of plate boundaries as likely areas of earthquakes and volcanic action (ESS-M-A3).
- f. GLE 13: Describe the processes responsible for earthquakes and volcanoes and identify the effects of these processes (e.g., faulting, folding) (ESS-M-A3).
- g. GLE 14: Distinguish between chemical and mechanical (physical) weathering and identify the role of weathering agents (e.g., wind, water, ice, gravity) (ESS-M-A4).
- h. GLE 15: Illustrate the role of organic processes in soil formation (ESS-M-A4).
- i. GLE 16: Compare the physical characteristics of rock and mineral specimens to observe that a rock is a mixture of minerals (ESS-M-A5).
- j. GLE 17: Describe the properties of minerals (e.g., color, luster, hardness, streak) (ESS-M-A5).
- k. GLE 18: Describe how sedimentary, igneous, and metamorphic rocks form and change in the rock cycle (ESS-M-A6).
- l. GLE 19: Determine the results of constructive and destructive forces upon landform development with the aid of geologic maps of Louisiana (ESS-M-A7).

m. GLE 20: Describe how humans' actions and natural processes have modified coastal regions in Louisiana and other locations (ESS-M-A8).

n. GLE 21: Read and interpret topographic maps (ESS-M-A9).

o. GLE 22: Compare ocean floor topography to continental topography by using topographic maps (ESS-M-A9).

p. GLE 23: Explain the processes of evaporation, condensation, precipitation, infiltration, transpiration, and sublimation as they relate to the water cycle (ESS-M-A10).

q. GLE 24: Investigate and explain how given factors affect the rate of water movement in the water cycle (e.g., climate, type of rock, ground cover) (ESS-M-A10).

r. GLE 25: Explain and give examples of how climatic conditions on earth are affected by the proximity of water (ESS-M-A11).

s. GLE 26: Describe and illustrate the layers of earth's atmosphere (ESS-M-A11).

t. GLE 27: Identify different air masses, jet streams, global wind patterns, and other atmospheric phenomena and describe how they relate to weather events, such as El Niño and La Niña (ESS-M-A12).

u. GLE 28: Use historical data to plot the movement of hurricanes and explain events or conditions that affected their paths (ESS-M-A12).

v. GLE 29: Make predictions about future weather conditions based on collected weather data (ESS-M-A12).

2. Earth History

a. GLE 30: Interpret a geologic timeline (ESS-M-B1).

b. GLE 31: Compare fossils from different geologic eras and areas of earth to show that life changes over time (ESS-M-B1).

c. GLE 32: Interpret a timeline starting with the birth of the solar system to the present day (ESS-M-B2).

d. GLE 33: Use historical data to draw conclusions about the age of earth (e.g., half-life, rock strata) (ESS-M-B2).

e. GLE 34: Apply geological principles to determine the relative ages of rock layers (e.g., original horizontality, superposition, cross-cutting relationships) (ESS-M-B3).

f. GLE 35: Describe how processes seen today are similar to those in the past (e.g., weathering, erosion, lithospheric plate movement) (ESS-M-B3).

3. Earth in the Solar System

a. GLE 36: Describe the life cycle of a star and predict the next likely stage of the sun (ESS-M-C1).

b. GLE 37: Use a Hertzsprung-Russell diagram and other data to compare the approximate mass, size, luminosity, temperature, structure, and composition of the sun to other stars (ESS-M-C1).

c. GLE 38: Use data to compare the planets in terms of orbit, size, composition, density, rotation, revolution, and atmosphere (ESS-M-C2).

d. GLE 39: Relate Newton's laws of gravity to the motions of celestial bodies and objects on earth (ESS-M-C3).

e. GLE 40: Identify and illustrate the relative positions of earth, the moon, and the sun during eclipses and phases of the moon (ESS-M-C4).

f. GLE 41: Describe the effects of the moon on tides (ESS-M-C4).

g. GLE 42: Interpret a scale model of the solar system (ESS-M-C5).

h. GLE 43: Identify the processes involved in the creation of land and sea breezes (ESS-M-C6).

i. GLE 44: Describe how unequal heating of earth's surface affects movement of air masses and water in the atmosphere and hydrosphere (ESS-M-C6).

j. GLE 45: Explain how seasonal changes are caused by the tilt of earth as it rotates on its axis and revolves around the sun (ESS-M-C7).

k. GLE 46: Illustrate and explain how the angle at which sunlight strikes earth produces changes in the seasons and length of daylight (ESS-M-C7).

l. GLE 47: Compare the relative distances from earth to the sun on the first day of summer and the first day of winter (ESS-M-C7).

m. GLE 48: Communicate ways that information from space exploration and technological research have advanced understanding about earth, the solar system, and the universe (ESS-M-C8).

n. GLE 49: Identify practical applications of technological advances resulting from space exploration and scientific and technological research (ESS-M-C8).

C. Science and the Environment: Strand Five

1. GLE 50: Illustrate possible point and non-point source contributions to pollution and natural or human-induced pathways of a pollutant in an ecosystem (SE-M-A3).

2. GLE 51: Analyze the consequences of human activities on global earth systems (SE-M-A4).

3. GLE 52: Describe the relationship between plant type and soil compatibility (SE-M-A9).

4. GLE 53: Distinguish among several examples of erosion (e.g., stream bank, topsoil, coastal) and describe common preventive measures (SE-M-A10).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 31:2793 (November 2005).

§1925. High School: Grades 9-12

A. Science as Inquiry: Strand One

1. The Abilities Necessary to Do Scientific Inquiry

a. GLE 1: Write a testable question or hypothesis when given a topic (SI-H-A1).

b. GLE 2: Describe how investigations can be observation, description, literature survey, classification, or experimentation (SI-H-A2).

c. GLE 3: Plan and record step-by-step procedures for a valid investigation, select equipment and materials, and identify variables and controls (SI-H-A2).

d. GLE 4: Conduct an investigation that includes multiple trials and record, organize, and display data appropriately (SI-H-A2).

e. GLE 5: Utilize mathematics, organizational tools, and graphing skills to solve problems (SI-H-A3).

f. GLE 6: Use technology when appropriate to enhance laboratory investigations and presentations of findings (SI-H-A3).

g. GLE 7: Choose appropriate models to explain scientific knowledge or experimental results (e.g., objects, mathematical relationships, plans, schemes, examples, role-playing, computer simulations) (SI-H-A4).

h. GLE 8: Give an example of how new scientific data can cause an existing scientific explanation to be supported, revised, or rejected (SI-H-A5).

i. GLE 9: Write and defend a conclusion based on logical analysis of experimental data (SI-H-A6) (SI-H-A2).

j. GLE 10: Given a description of an experiment, identify appropriate safety measures (SI-H-A7).

2. Understanding Scientific Inquiry

a. GLE 11: Evaluate selected theories based on supporting scientific evidence (SI-H-B1).

b. GLE 12: Cite evidence that scientific investigations are conducted for many different reasons (SI-H-B2).

c. GLE 13: Identify scientific evidence that has caused modifications in previously accepted theories (SI-H-B2).

d. GLE 14: Cite examples of scientific advances and emerging technologies and how they affect society (e.g., MRI, DNA in forensics) (SI-H-B3).

e. GLE 15: Analyze the conclusion from an investigation by using data to determine its validity (SI-H-B4).

f. GLE 16: Use the following rules of evidence to examine experimental results.

i. Can an expert's technique or theory be tested, has it been tested, or is it simply a subjective, conclusive approach that cannot be reasonably assessed for reliability?

ii. Has the technique or theory been subjected to peer review and publication?

iii. What is the known or potential rate of error of the technique or theory when applied?

iv. Were standards and controls applied and maintained?

v. Has the technique or theory been generally accepted in the scientific community? (SI-H-B5) (SI-H-B1) (SI-H-B4).

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§1927. Physical Science (Recommended for Grade 9)

A. Physical Science: Strand Two

1. Measurement and Symbolic Representation

a. GLE 1: Measure the physical properties of different forms of matter in metric system units (e.g., length, mass, volume, temperature) (PS-H-A1).

b. GLE 2: Gather and organize data in charts, tables, and graphs (PS-H-A1).

c. GLE 3: Distinguish among symbols for atoms, ions, molecules, and equations for chemical reactions (PS-H-A2).

d. GLE 4: Name and write chemical formulas using symbols and subscripts (PS-H-A2).

2. Atomic Structure

a. GLE 5: Identify the three subatomic particles of an atom by location, charge, and relative mass (PS-H-B1).

b. GLE 6: Determine the number of protons, neutrons, and electrons of elements by using the atomic number and atomic mass from the periodic table (PS-H-B1).

c. GLE 7: Describe the results of loss/gain of electrons on charges of atoms (PS-H-B1) (PS-H-C5).

d. GLE 8: Evaluate the uses and effects of radioactivity in people's daily lives (PS-H-B2).

e. GLE 9: Compare nuclear fission to nuclear fusion (PS-H-B2).

f. GLE 10: Identify the number of valence electrons of the first 20 elements based on their positions in the periodic table (PS-H-B3).

3. The Structure and Properties of Matter

a. GLE 11: Investigate and classify common materials as *elements*, *compounds*, or *mixtures* (heterogeneous or homogeneous) based on their physical and chemical properties (PS-H-C1).

b. GLE 12: Classify elements as *metals* or *nonmetals* based on their positions in the periodic table (PS-H-C2).

c. GLE 13: Predict how factors such as particle size and temperature influence the rate of dissolving (PS-H-C3).

d. GLE 14: Investigate and compare methods for separating mixtures by using the physical properties of the components (PS-H-C4) (PS-H-C1).

e. GLE 15: Using selected elements from atomic numbers 1 to 20, draw Bohr models (PS-H-C5) (PS-H-B3).

f. GLE 16: Name and write the formulas for simple ionic and covalent compounds (PS-H-C5).

g. GLE 17: Name and predict the bond type formed between selected elements based on their locations in the periodic table (PS-H-C5).

h. GLE 18: Diagram or construct models of simple hydrocarbons (four or fewer carbons) with single, double, or triple bonds (PS-H-C6).

i. GLE 19: Analyze and interpret a graph that relates temperature and heat energy absorbed during phase changes of water (PS-H-C7).

j. GLE 20: Predict the particle motion as a substance changes phases (PS-H-C7) (PS-H-C3).

4. Chemical Reactions

a. GLE 21: Classify changes in matter as *physical* or *chemical* (PS-H-D1).

b. GLE 22: Identify evidence of chemical changes (PS-H-D1).

c. GLE 23: Classify unknowns as *acidic*, *basic*, or *neutral* using indicators (PS-H-D2).

d. GLE 24: Identify balanced equations as neutralization, combination, and decomposition reactions (PS-H-D3).

e. GLE 25: Determine the effect of various factors on reaction rate (e.g., temperature, surface area, concentration, agitation) (PS-H-D4).

f. GLE 26: Illustrate the laws of conservation of matter and energy through balancing simple chemical reactions (PS-H-D5) (PS-H-D3) (PS-H-D7).

g. GLE 27: Distinguish between endothermic and exothermic reactions (PS-H-D6).

h. GLE 28: Identify chemical reactions that commonly occur in the home and nature (PS-H-D7).

5. Forces and Motion

a. GLE 29: Differentiate between *mass* and *weight* (PS-H-E1).

b. GLE 30: Compare the characteristics and strengths of forces in nature (e.g., gravitational, electrical, magnetic, nuclear) (PS-H-E1).

c. GLE 31: Differentiate between speed and velocity (PS-H-E2).

d. GLE 32: Plot and compare line graphs of acceleration and velocity (PS-H-E2).

e. GLE 33: Calculate velocity and acceleration using equations (PS-H-E2).

f. GLE 34: Demonstrate Newton's three laws of motion (e.g., inertia, net force using $F = ma$, equal and opposite forces) (PS-H-E3).

g. GLE 35: Describe and demonstrate the motion of common objects in terms of the position of the observer (PS-H-E4).

6. Energy

a. GLE 36: Measure and calculate the relationships among energy, work, and power (PS-H-F1).

b. GLE 37: Model and explain how momentum is conserved during collisions (PS-H-F2).

c. GLE 38: Analyze diagrams to identify changes in kinetic and potential energy (PS-H-F2).

d. GLE 39: Distinguish among thermal, chemical, electromagnetic, mechanical, and nuclear energy (PS-H-F2).

e. GLE 40: Demonstrate energy transformation and conservation in everyday actions (PS-H-F2).

7. Interactions of Energy and Matter

a. GLE 41: Identify the parts and investigate the properties of transverse and compression waves (PS-H-G1).

b. GLE 42: Describe the relationship between wavelength and frequency (PS-H-G1).

c. GLE 43: Investigate and construct diagrams to illustrate the laws of reflection and refraction (PS-H-G1).

d. GLE 44: Illustrate the production of static electricity (PS-H-G2).

e. GLE 45: Evaluate diagrams of series and parallel circuits to determine the flow of electricity (PS-H-G2).

f. GLE 46: Diagram a magnetic field (PS-H-G2).

g. GLE 47: Explain how electricity and magnetism are related (PS-H-G2).

h. GLE 48: Compare properties of waves in the electromagnetic spectrum (PS-H-G3).

i. GLE 49: Describe the Doppler effect on sound (PS-H-G3).

j. GLE 50: Identify positive and negative effects of electromagnetic/mechanical waves on humans and human activities (e.g., sound, ultraviolet rays, X-rays, MRIs, fiber optics) (PS-H-G4) (PS-H-G3).

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§1929. Biology (Recommended for Grade 10)

A. Life Science: Strand One

1. The Cell

a. GLE 1: Compare prokaryotic and eukaryotic cells (LS-H-A1).

b. GLE 2: Identify and describe structural and functional differences among organelles (LS-H-A1).

c. GLE 3: Investigate and describe the role of enzymes in the function of a cell (LS-H-A1).

d. GLE 4: Compare active and passive cellular transport (LS-H-A2).

e. GLE 5: Analyze the movement of water across a cell membrane in hypotonic, isotonic, and hypertonic solutions (LS-H-A2).

f. GLE 6: Analyze a diagram of a developing zygote to determine when cell differentiation occurs (LS-H-A3).

2. The Molecular Basis of Heredity

a. GLE 7: Identify the basic structure and function of nucleic acids (e.g., DNA, RNA) (LS-H-B1).

b. GLE 8: Describe the relationships among DNA, genes, chromosomes, and proteins (LS-H-B1).

c. GLE 9: Compare mitosis and meiosis (LS-H-B2).

d. GLE 10: Analyze pedigrees to identify patterns of inheritance for common genetic disorders (LS-H-B3).

e. GLE 11: Calculate the probability of genotypes and phenotypes of offspring given the parental genotypes (LS-H-B3).

f. GLE 12: Describe the processes used in modern biotechnology related to genetic engineering (LS-H-B4) (LS-H-B1).

g. GLE 13: Identify possible positive and negative effects of advances in biotechnology (LS-H-B4) (LS-H-B1).

3. Biological Evolution

a. GLE 14: Analyze evidence on biological evolution, utilizing descriptions of existing investigations, computer models, and fossil records (LS-H-C1).

b. GLE 15: Compare the embryological development of animals in different phyla (LS-H-C1) (LS-H-A3).

c. GLE 16: Explain how DNA evidence and fossil records support Darwin's theory of evolution (LS-H-C2).

d. GLE 17: Explain how factors affect gene frequency in a population over time (LS-H-C3).

e. GLE 18: Classify organisms from different kingdoms at several taxonomic levels, using a dichotomous key (LS-H-C4).

f. GLE 19: Compare characteristics of the major kingdoms (LS-H-C5).

g. GLE 20: Analyze differences in life cycles of selected organisms in each of the kingdoms (LS-H-C6).

h. GLE 21: Compare the structures, functions, and cycles of viruses to those of cells (LS-H-C7).

i. GLE 22: Describe the role of viruses in causing diseases and conditions (e.g., AIDS, common colds, smallpox, influenza, warts) (LS-H-C7) (LS-H-G2).

4. Interdependence of Organisms

a. GLE 23: Illustrate the flow of carbon, nitrogen, and water through an ecosystem (LS-H-D1) (SE-H-A6).

b. GLE 24: Analyze food webs by predicting the impact of the loss or gain of an organism (LS-H-D2).

c. GLE 25: Evaluate the efficiency of the flow of energy and matter through a food chain/pyramid (LS-H-D2).

d. GLE 26: Analyze the dynamics of a population with and without limiting factors (LS-H-D3).

e. GLE 27: Analyze positive and negative effects of human actions on ecosystems (LS-H-D4) (SE-H-A7).

5. Matter, Energy, and Organization of Living Systems

a. GLE 28: Explain why ecosystems require a continuous input of energy from the sun (LS-H-E1).

b. GLE 29: Use balanced equations to analyze the relationship between photosynthesis and cellular respiration (LS-H-E1).

c. GLE 30: Explain the role of adenosine triphosphate (ATP) in a cell (LS-H-E2).

d. GLE 31: Compare the levels of organization in the biosphere (LS-H-E3).

6. Systems and the Behavior of Organisms

a. GLE 32: Analyze the interrelationships of organs in major systems (LS-H-F1) (LS-H-E3).

b. GLE 33: Compare structure to function of organs in a variety of organisms (LS-H-F1).

c. GLE 34: Explain how body systems maintain homeostasis (LS-H-F2).

d. GLE 35: Explain how selected organisms respond to a variety of stimuli (LS-H-F3).

e. GLE 36: Explain how behavior affects the survival of species (LS-H-F4).

7. Personal and Community Health

a. GLE 37: Explain how fitness and health maintenance can result in a longer human life span (LS-H-G1).

b. GLE 38: Discuss mechanisms of disease transmission and processes of infection (LS-H-G2) (LS-H-G4).

c. GLE 39: Compare the functions of the basic components of the human immune system (LS-H-G3).

d. GLE 40: Determine the relationship between vaccination and immunity (LS-H-G3).

e. GLE 41: Describe causes, symptoms, treatments, and preventions of major communicable and noncommunicable diseases (LS-H-G4).

f. GLE 42: Summarize the uses of selected technological developments related to the prevention, diagnosis, and treatment of diseases or disorders (LS-H-G5).

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§1931. Earth Science (Recommended for Grades 11/12)

A. Earth and Space Science: Strand Four

1. Energy in Earth's System

a. GLE 1: Describe what happens to the solar energy received by earth every day (ESS-H-A1).

b. GLE 2: Trace the flow of heat energy through the processes in the water cycle (ESS-H-A1).

c. GLE 3: Describe the effect of natural insulation on energy transfer in a closed system (ESS-H-A1).

d. GLE 4: Describe the relationship between seasonal changes in the angle of incoming solar radiation and its consequences to earth's temperature (e.g., direct vs. slanted rays) (ESS-H-A2).

e. GLE 5: Explain how the process of fusion inside the sun provides the external heat source for earth (ESS-H-A3).

f. GLE 6: Discuss how heat energy is generated at the inner core-outer core boundary (ESS-H-A4).

g. GLE 7: Analyze how radiant heat from the sun is absorbed and transmitted by several different earth materials (ESS-H-A5).

h. GLE 8: Explain why weather only occurs in the tropospheric layer of earth's atmosphere (ESS-H-A5).

i. GLE 9: Compare the structure, composition, and function of the layers of earth's atmosphere (ESS-H-A6).

j. GLE 10: Analyze the mechanisms that drive weather and climate patterns and relate them to the three methods of heat transfer (ESS-H-A6).

k. GLE 11: Describe the processes that drive lithospheric plate movements (i.e., radioactive decay, friction, convection) (ESS-H-A7) (ESS-H-A3) (ESS-H-A4).

l. GLE 12: Relate lithospheric plate movements to the occurrences of earthquakes, volcanoes, mid-ocean ridge systems, and off-shore trenches found on earth (ESS-H-A7).

2. Geochemical Cycles

a. GLE 13: Explain how stable elements and atoms are recycled during natural geologic processes (ESS-H-B1).

b. GLE 14: Compare the conditions of mineral formation with weathering resistance at earth's surface (ESS-H-B1).

c. GLE 15: Identify the sun-driven processes that move substances at or near earth's surface (ESS-H-B2).

3. The Origin and Evolution of the Earth System

a. GLE 16: Use the nebular hypothesis to explain the formation of a solar system (ESS-H-C1).

b. GLE 17: Determine the relative ages of rock layers in a geologic profile or cross section (ESS-H-C2).

c. GLE 18: Use data from radioactive dating techniques to estimate the age of earth materials (ESS-H-C2).

d. GLE 19: Interpret geological maps of Louisiana to describe the state's geologic history (ESS-H-C3).

e. GLE 20: Determine the chronological order of the five most recent major lobes of the Mississippi River delta in Louisiana (ESS-H-C3).

f. GLE 21: Use fossil records to explain changes in the concentration of atmospheric oxygen over time (ESS-H-C4).

g. GLE 22: Analyze data related to a variety of natural processes to determine the time frame of the changes involved (e.g., formation of sedimentary rock layers, deposition of ash layers, fossilization of plant or animal species) (ESS-H-C5).

4. The Origin and Evolution of the Universe

a. GLE 23: Identify the evidence that supports the big bang theory (ESS-H-D1).

b. GLE 24: Describe the organization of the known universe (ESS-H-D2).

c. GLE 25: Using the surface temperature and absolute magnitude data of a selected star, locate its

placement on the Hertzsprung-Russell diagram and infer its color, size, and life stage (ESS-H-D3).

d. GLE 26: Identify the elements present in selected stars, given spectrograms of known elements and those of the selected stars (ESS-H-D4).

e. GLE 27: Trace the movement and behavior of hydrogen atoms during the process of fusion as it occurs in stars like the sun (ESS-H-D5).

f. GLE 28: Identify the relationship between orbital velocity and orbital diameter (ESS-H-D6) (PS-H-E2).

g. GLE 29: Demonstrate the elliptical shape of earth's orbit and describe how the point of orbital focus changes during the year (ESS-H-D6).

h. GLE 30: Summarize how current technology has directly affected our knowledge of the universe (ESS-H-D7).

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§1933. Environmental Science (Recommended for Grades 11/12)

A. Science and the Environment: Strand Five

1. Ecological Systems and Interactions

a. GLE 1: Describe the abiotic and biotic factors that distinguish earth's major ecological systems (SE-H-A1).

b. GLE 2: Describe the characteristics of major biomes on earth (SE-H-A1).

c. GLE 3: Use the 10 percent rule and data analysis to measure the flow of energy as represented by biomass in a system (SE-H-A2).

d. GLE 4: Determine the effects of limiting factors on a population and describe the concept of carrying capacity (SE-H-A3).

e. GLE 5: Examine and discuss the major stages of succession, describing the generalized sequential order of the types of plant species (SE-H-A4).

f. GLE 6: Analyze the consequences of changes in selected divisions of the biosphere (e.g., ozone depletion, global warming, acid rain) (SE-H-A5) (SE-H-A7).

g. GLE 7: Illustrate the flow of carbon, water, oxygen, nitrogen, and phosphorus through an ecosystem (SE-H-A6) (LS-H-D1).

h. GLE 8: Explain how species in an ecosystem interact and link in a complex web (SE-H-A7) (SE-H-A10).

i. GLE 9: Cite and explain examples of organisms' adaptations to environmental pressures over time (SE-H-A8).

j. GLE 10: Analyze the effect of an invasive species on the biodiversity within ecosystems (SE-H-A9).

k. GLE 11: Explain why biodiversity is essential to the survival of organisms (SE-H-A9).

1. GLE 12: Give examples and describe the effect of pollutants on selected populations (SE-H-A11).

2. Resources and Resource Management

a. GLE 13: Evaluate whether a resource is renewable by analyzing its relative regeneration time (SE-H-B1).

b. GLE 14: Analyze data to determine the effect of preservation practices compared to conservation practices for a sample species (SE-H-B2).

c. GLE 15: Identify the factors that cause the inequitable distribution of earth's resources (e.g., politics, economics, climate) (SE-H-B3).

d. GLE 16: Evaluate the effectiveness of natural resource management in Louisiana (SE-H-B4) (SE-H-B5).

e. GLE 17: Analyze data to determine when reuse, recycling, and recovery are applicable (SE-H-B5).

f. GLE 18: Identify the factors that affect sustainable development (SE-H-B6).

3. Environmental Awareness and Protection

a. GLE 19: Determine the interrelationships of clean water, land, and air to the success of organisms in a given population (SE-H-C1).

b. GLE 20: Relate environmental quality to quality of life (SE-H-C2).

c. GLE 21: Analyze the effect of common social, economic, technological, and political considerations on environmental policy (SE-H-C3).

d. GLE 22: Analyze the risk-benefit ratio for selected environmental situations (SE-H-C4).

e. GLE 23: Describe the relationship between public support and the enforcement of environmental policies (SE-H-C5).

4. Personal Choices and Responsible Actions

a. GLE 24: Identify the advantages and disadvantages of using disposable items versus reusable items (SE-H-D1).

b. GLE 25: Discuss how education and collaboration can affect the prevention and control of a selected pollutant (SE-H-D2) (SE-H-D3).

c. GLE 26: Determine local actions that can affect the global environment (SE-H-D4).

d. GLE 27: Describe how accountability toward the environment affects sustainability (SE-H-D5).

e. GLE 28: Discuss the reduction of combustible engines needed to significantly decrease CO₂ in the troposphere (SE-H-D6).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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§1935. Chemistry (Recommended for Grades 11/12)

A. Physical Science: Strand Two

1. Measurement and Symbolic Representation

a. GLE 1: Convert metric system units involving length, mass, volume, and time using dimensional analysis (i.e., factor-label method) (PS-H-A1).

b. GLE 2: Differentiate between accuracy and precision and evaluate percent error (PS-H-A1).

c. GLE 3: Determine the significant figures based on precision of measurement for stated quantities (PS-H-A1).

d. GLE 4: Use scientific notation to express large and small numbers (PS-H-A1).

e. GLE 5: Write and name formulas for ionic and covalent compounds (PS-H-A2).

f. GLE 6: Write and name the chemical formula for the products that form from the reaction of selected reactants (PS-H-A2).

g. GLE 7: Write a balanced symbolic equation from a word equation (PS-H-A2).

2. Atomic Structure

a. GLE 8: Analyze the development of the modern atomic theory from a historical perspective (PS-H-B1).

b. GLE 9: Draw accurate valence electron configurations and Lewis dot structures for selected molecules, ionic and covalent compounds, and chemical equations (PS-H-B1).

c. GLE 10: Differentiate among *alpha*, *beta*, and *gamma* emissions (PS-H-B2).

d. GLE 11: Calculate the amount of radioactive substance remaining after a given number of half-lives has passed (PS-H-B2).

e. GLE 12: Describe the uses of radioactive isotopes and radiation in such areas as plant and animal research, health care, and food preservation (PS-H-B2).

f. GLE 13: Identify the number of bonds an atom can form given the number of valence electrons (PS-H-B3).

3. The Structure and Properties of Matter

a. GLE 14: Identify unknowns as elements, compounds, or mixtures based on physical properties (e.g., density, melting point, boiling point, solubility) (PS-H-C1).

b. GLE 15: Predict the physical and chemical properties of an element based only on its location in the periodic table (PS-H-C2).

c. GLE 16: Predict the stable ion(s) an element is likely to form when it reacts with other specified elements (PS-H-C2).

d. GLE 17: Use the periodic table to compare electronegativities and ionization energies of elements to explain periodic properties, such as atomic size (PS-H-C2).

e. GLE 18: Given the concentration of a solution, calculate the predicted change in its boiling and freezing points (PS-H-C3).

f. GLE 19: Predict the conductivity of a solution (PS-H-C3).

g. GLE 20: Express concentration in terms of molarity, molality, and normality (PS-H-C3).

h. GLE 21: Design and conduct a laboratory investigation in which physical properties are used to separate the substances in a mixture (PS-H-C4).

i. GLE 22: Predict the kind of bond that will form between two elements based on electronic structure and electronegativity of the elements (e.g., ionic, polar, nonpolar) (PS-H-C5).

j. GLE 23: Model chemical bond formation by using Lewis dot diagrams for ionic, polar, and nonpolar compounds (PS-H-C5).

k. GLE 24: Describe the influence of intermolecular forces on the physical and chemical properties of covalent compounds (PS-H-C5).

l. GLE 25: Name selected structural formulas of organic compounds (PS-H-C6).

m. GLE 26: Differentiate common biological molecules, such as carbohydrates, lipids, proteins, and nucleic acids by using structural formulas (PS-H-C6).

n. GLE 27: Investigate and model hybridization in carbon compounds (PS-H-C6).

o. GLE 28: Name, classify, and diagram *alkanes*, *alkenes*, and *alkynes* (PS-H-C6).

p. GLE 29: Predict the properties of a gas based on gas laws (e.g., temperature, pressure, volume) (PS-H-C7).

q. GLE 30: Solve problems involving heat flow and temperature changes by using known values of specific heat and latent heat of phase change (PS-H-C7).

4. Chemical Reactions

a. GLE 31: Describe chemical changes and reactions using diagrams and descriptions of the reactants, products, and energy changes (PS-H-D1).

b. GLE 32: Determine the concentration of an unknown acid or base by using data from a titration with a standard solution and an indicator (PS-H-D2).

c. GLE 33: Calculate pH of acids, bases, and salt solutions based on the concentration of hydronium and hydroxide ions (PS-H-D2).

d. GLE 34: Describe chemical changes by developing word equations, balanced formula equations, and net ionic equations (PS-H-D3).

e. GLE 35: Predict products (with phase notations) of simple reactions, including acid/base, oxidation/reduction, and formation of precipitates (PS-H-D3).

f. GLE 36: Identify the substances gaining and losing electrons in simple oxidation-reduction reactions (PS-H-D3).

g. GLE 37: Predict the direction of a shift in equilibrium in a system as a result of stress by using LeChatalier's principle (PS-H-D4).

h. GLE 38: Relate the law of conservation of matter to the rearrangement of atoms in a balanced chemical equation (PS-H-D5).

i. GLE 39: Conduct an investigation in which the masses of the reactants and products from a chemical reaction are calculated (PS-H-D5).

j. GLE 40: Compute percent composition, empirical formulas, and molecular formulas of selected compounds in chemical reactions (PS-H-D5).

k. GLE 41: Apply knowledge of stoichiometry to solve mass/mass, mass/volume, volume/volume, and mole/mole problems (PS-H-D5).

l. GLE 42: Differentiate between activation energy in endothermic reactions and exothermic reactions (PS-H-D6).

m. GLE 43: Graph and compute the energy changes that occur when a substance, such as water, goes from a solid to a liquid state, and then to a gaseous state (PS-H-D6).

n. GLE 44: Measure and graph energy changes during chemical reactions observed in the laboratory (PS-H-D6).

o. GLE 45: Give examples of common chemical reactions, including those found in biological systems (PS-H-D7).

5. Forces and Motion

a. GLE 46: Identify and compare intermolecular forces and their effects on physical and chemical properties (PS-H-E1).

6. Interactions of Energy and Matter

a. GLE 47: Assess environmental issues related to the storage, containment, and disposal of wastes associated with energy production and use (PS-H-G4).

NOTE: The foundation skills addressed by each benchmark are listed numerically in parenthesis after the benchmark.

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§1937. Physics (Recommended for Grades 11/12)

A. Physical Science: Strand Two

1. Measurement and Symbolic Representation

a. GLE 1: Measure and determine the physical quantities of an object or unknown sample using correct prefixes and metric system units (e.g., mass, charge, pressure, volume, temperature, density) (PS-H-A1).

b. GLE 2: Determine and record measurements correctly using significant digits and scientific notation (PS-H-A1).

c. GLE 3: Determine accuracy and precision of measured data (PS-H-A1).

d. GLE 4: Perform dimensional analysis to verify problem set-up (PS-H-A1).

e. GLE 5: Use trigonometric functions to make indirect measurements (PS-H-A1).

2. Forces and Motion

a. GLE 6: Explain the role of strong nuclear forces and why they are the strongest of all forces (PS-H-E1).

b. GLE 7: Relate gravitational force to mass and distance (PS-H-E1).

c. GLE 8: Compare and calculate electrostatic forces acting within and between atoms to the gravitational forces acting between atoms (PS-H-E1).

d. GLE 9: Describe and measure motion in terms of position, displacement time, and the derived quantities of velocity and acceleration (PS-H-E2).

e. GLE 10: Determine constant velocity and uniform acceleration mathematically and graphically (PS-H-E2).

f. GLE 11: Plot and interpret displacement-time and velocity-time graphs and explain how these two types of graphs are interrelated (PS-H-E2).

g. GLE 12: Model scalar and vector quantities (PS-H-E2).

h. GLE 13: Solve for missing variables in kinematic equations relating to actual situations (PS-H-E2).

i. GLE 14: Add and resolve vectors graphically and mathematically to determine resultant/equilibrant of concurrent force vectors (PS-H-E3).

j. GLE 15: Calculate centripetal force and acceleration in circular motion (PS-H-E3).

k. GLE 16: Analyze circular motion to solve problems relating to angular velocity, acceleration, momentum, and torque (PS-H-E3).

l. GLE 17: Analyze simple harmonic motion (PS-H-E3).

m. GLE 18: Demonstrate the independence of perpendicular components in projectile motion and predict the optimum angles and velocities of projectiles (PS-H-E3).

3. Energy

a. GLE 19: Explain quantitatively the conversion between kinetic and potential energy for objects in motion (e.g., roller coaster, pendulum) (PS-H-F1).

b. GLE 20: Calculate the mechanical advantage and efficiency of simple machines and explain the loss of efficiency using the dynamics of the machines (PS-H-F1).

c. GLE 21: Explain and calculate the conversion of one form of energy to another (e.g., chemical to thermal, thermal to mechanical, magnetic to electrical) (PS-H-F1).

d. GLE 22: Analyze energy transformations using the law of conservation of energy (PS-H-F2).

e. GLE 23: Apply the law of conservation of momentum to collisions in one and two dimensions, including angular momentum (PS-H-F2).

f. GLE 24: Apply the concept of momentum to actual situations with different masses and velocities (PS-H-F2).

4. Interactions of Energy and Matter

a. GLE 25: Determine the relationships among amplitude, wavelength, frequency, period, and velocity in different media (PS-H-G1).

b. GLE 26: Evaluate how different media affect the properties of reflection, refraction, diffraction, polarization, and interference (PS-H-G1).

c. GLE 27: Investigate and construct diagrams to illustrate the laws of reflection and refraction (PS-H-G1).

d. GLE 28: Draw constructive and destructive interference patterns and explain how the principle of superposition applies to wave propagation (PS-H-G1).

e. GLE 29: Describe observed electrostatic phenomena, calculate Coulomb's law, and test charge pole, electric field, and magnetic field (PS-H-G2).

f. GLE 30: Construct basic electric circuits and solve problems involving voltage, current, resistance, power, and energy (PS-H-G2).

g. GLE 31: Describe the relationship of electricity, magnetism, and inductance as aspects of a single electromagnetic force (PS-H-G2).

h. GLE 32: Compare properties of electromagnetic and mechanical waves (PS-H-G3).

i. GLE 33: Solve problems related to sound and light in different media (PS-H-G3).

j. GLE 34: Compare the properties of the electromagnetic spectrum as a wave and as a particle (PS-H-G3).

k. GLE 35: Analyze the Doppler effect of a moving wave source (PS-H-G3).

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Chapter 21. Glossary and References

§2101. Definitions

Ability—power to perform, whether physical, moral, intellectual, or legal; skill or competence.

Analyzing—to separate mentally all parts (of a whole) as to reveal their relation to it and to one another.

Assessment—the systematic, multistep process involving the collection and interpretation of educational data.

Benchmark—specify what students should know and be able to do.

Conserving—the use of natural resources in a way that assures their continuing availability to future generations; the intelligent use of natural resources for long-term benefits.

Consumer—any organism that feeds from another.

Content Standards—broad statement of process and/or content that are used as a reference to develop curriculum and assess student progress.

Curriculum—a document (usually developed at the local level) which aides teachers in planning instruction. The way content is delivered. It includes the structure, organization, balance, and presentation of the content in the classroom. Note: This definition includes instructional materials, and the teacher's strategies, behaviors, and assessment.

Demonstrate—to prove by reasoning, as by deduction; to establish as true.

Describing—to represent by words; to give an account of.

Energy—the capacity to perform work, or the potential for power and activity.

Energy Resources—origins of natural energy (coal, oil, gas, etc.).

Experimentation—practice by experiment; a trial made to confirm or disprove something doubtful; an operation made to discover some unknown principle or effect.

EDUCATION

Framework—a document (usually developed at the state level) which provides a vision of how the national standards can best be implemented, given the characteristics of that particular state.

Inquiry—a seeking for information by asking questions; interrogation; a question or questioning.

Instructional—the physical components of the curriculum, including textbooks, materials software, kits, and teachers' guides.

Knowing—informed; intelligent; having or displaying discernment.

Preserving—protection which emphasizes nonconsumptive values and uses, including no direct use by humans, contrasted with conservation which emphasizes both consumptive and nonconsumptive values and uses.

Producer—any organism that is capable of making its own food.

Recognize—to avow knowledge of; to admit with formal acknowledgment.

Scientific Investigation—to follow up or make research by patient inquiry and observation and examination of the facts.

Skill—a particular art or science; now a developed or acquired ability; the ability to use one's knowledge effectively; technically proficient.

Understanding—power to understand; capability of comprehending and judging; the rational powers taken collectively.

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Title 28

EDUCATION

Index

Benchmarks 5-8, 8, 9, 12, 14, 16	Kindergarten, 18
Benchmarks 9-12, 8, 10, 12, 15, 16	Large-Scale Assessment, 6
Benchmarks K-4, 7, 9, 11, 13, 16	Life Science, 11
Biology (Recommended for Grade 10), 38	Louisiana Content Standards Foundation Skills, 2
Chemistry (Recommended for Grades 11/12), 41	Materials and Equipment, 5
Classroom Assessment, 6	Middle School
Definitions, 43	Grades 5-8, 29
Earth and Space Science, 13	Nature of Science, 4
Earth Science (Recommended for Grades 11/12), 39	Need and Context for Reform, 1
Environmental Science	Philosophy of Science Education, 1
(Recommended for Grades 11/12), 40	Physical Science, 9
Fifth Grade, 26	Physical Science (Recommended for Grade 9), 36
First Grade, 19	Physics (Recommended for Grades 11/12), 42
Fourth Grade, 24	Prekindergarten, 17
Grade 5, 30	Purpose of Assessment, 6
Grade 6, 31	Purpose of the Framework, 2
Grade 7, 33	Science and Equity, 5
Grade 8, 34	Science and the Environment, 15
High School	Science As Inquiry, 7
Grades 9-12, 36	Science Strands, 7
Information Literacy Model for Lifelong Learning, 3	Second Grade, 20
Instructional Issues, 4	Technology, 5
Intended Audiences, 2	Third Grade, 22
Intended Use, 2	Unifying Concepts and Processes, 4